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ABSTRACT

We estimate the causal impact of countercyclical interest rates on macroeconomic outcomes in open economies. To identify countercyclical interest rates, we construct a new database of short-term interest rates, principal exports, and international commodity prices for 40 economies from 1870 to 1913. This era of capital mobility, nominal anchors, specialization and trade integration, exposed economies to multiple exogenous demand-side shocks. Specialization and trade integration subjected economies to a “commodity lottery” in the form of price fluctuations in world markets. Capital mobility and a currency peg exposed them to interest-rate movements originating in the U.K., the largest economy and linchpin of the classical gold standard. We identify (i) positive effects of commodity-export prices on real GDP and the domestic price level and (ii) negative effects of exogenous changes in short-term interest rates on the same variables. We then show that countercyclical interest rates, defined relative to export-price shocks, stabilized both output and the domestic price level. This stabilization was more effective for the price level than for output.

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1. Introduction

Do countercyclical interest rates stabilize macroeconomic variables in open economies? Performing macroeconomic stabilization following external shocks is crucial for policy makers in these economies. However, providing causal empirical evidence on this question is difficult because both shocks and policy interest rates are often endogenous to underlying economic conditions. Hence, research on the effects of countercyclical interest rates has largely focused on theoretical models and calibration exercises.[1]

In this paper, we address this lacuna by examining the behavior of economies during the classical gold standard era. Although policy makers at this time were likely not explicitly engaged in stabilization policy, this earlier era of open economies and trade integration provides a unique setting where we can identify plausibly exogenous shocks that allow for the estimation of the causal effects of countercyclical interest rates. Specifically, these shocks are: (1) fluctuations in principal export-prices, mostly commodity prices determined in world markets, and (2) interest-rate shocks that responded to interest-rate movements in the United Kingdom (the linchpin of the international monetary system during our sample period) for economies adhering to currency pegs (i.e., the classical gold standard). Armed with these two plausibly exogenous shocks, we then use different combinations of them to obtain causal estimates for the effects of countercyclical interest rates on real output and the price level.

To do so, we construct a new database of short-term interest rates, principal exports, and international export prices for 40 economies from 1870 to 1913, and focus our analysis on economies that adhered to the classical gold standard during this period. First, we estimate the causal impact of export-price shocks on output and domestic prices while taking interest rates as given. We focus on the price of the principal export for a given economy, instead of a portfolio of exports, since this is plausibly a more exogenous determinant of income. We find that positive export-price shocks increase real GDP per capita and the price level. A one-standard-deviation increase in the price of a

[1] See Corsetti et. al. (2010) for a review of this approach. State-dependent empirical analysis of monetary shocks, for example, by Jordà et al. (2020), usually defines the state using the output gap, which is an endogenous variable.

country's principal export causes real GDP per capita to be about 0.5 percent larger after five years and the price level to be 2 percent higher after three years.

These findings relate to a large literature estimating the impact of trade-related and commodity-price shocks in open economies. Fernández et al. (2017) document that commodity prices account for significant fluctuations in output, while Schmitt-Grohe and Uribe (2017) show smaller effects. Gelos and Ustyugova (2017) study inflation responses to commodity-price shocks. Benguria et al. (2018) show that higher commodity prices increase domestic demand through a wealth channel and induce wage increases. Mendoza (1995), Kose (2002) and Drechsel and Tenreyro (2018) show theoretically how commodity booms and busts affect output, consumption, and investment.

Our primary focus is on how commodity price shocks depend on the monetary stance in the economy; however, our analysis also contributes to understanding short-run macroeconomic effects during the first global monetary system. Previous research for the classical gold standard era has analyzed the long-run effects of the commodity lottery on output (Blattman et al., 2007) or the short-run effects of commodity-price shocks on currency risk (Mitchener and Pina, 2020). We contribute to this literature by showing that, during this earlier era of large global trade flows, principal export-price shocks (primarily commodities) were an important driver of output and prices in the short and medium run.

We then combine these export-price shocks with interest-rate shocks to produce causal estimates of state-dependent interest rates on macroeconomic outcomes. To estimate the effects of interest-rate shocks, we employ an instrumental variables (IV) local-projections approach that is based on the policy trilemma in international finance, which states that in the absence of capital controls, under fixed exchange rates economies do not have independent monetary policy (di

Giovanni and Shambaugh, 2008; di Giovanni et al., 2009; Jordà et al., 2015; Jordà et al., 2020).[2] We do this for the sub-sample of economies adhering to the gold standard for which we also have data on *domestic* interest rates during our sample period. In our baseline estimation for economies formally adhering to the classical gold standard, the contemporaneous pass-through of UK interest-rate shocks (the base country during our sample period) to other economies is 0.3. This approach allows us to capture the causal effect of domestic interest rates on economic activity. We find that increases in interest rates reduce output and prices, results that are consistent with related research (di Giovanni and Shambaugh, 2008; di Giovanni et al., 2009; Jordà et al., 2015, 2020). A one-standard-deviation increase in UK interest rates, or a 0.3 increase in domestic interest rates, reduces real GDP in other economies by 1 percent and the price level by 2.5 percent after five years.

Since the export-shocks and interest-rate shocks described above are not perfectly correlated with each other during our sample period, we can estimate the causal impact from different combinations of shocks – our main contribution to the literature. In particular, we are able to investigate combinations that capture *countercyclical* interest rates. Specifically, we provide estimates of the local average treatment effect for two scenarios that we refer to as countercyclical: (1) how prices and output respond when interest rates and export prices both increase and (2) how prices and output react when interest rates and export prices both decline. We then compare the effect of export price shocks on macroeconomic variables under these countercyclical cases to procyclical or acyclical combinations of shocks. Crucially, for both the reduced form and the structural IV approaches that we employ, we use the exogenous UK interest rate instead of the domestic interest rate to define whether a particular combination of shocks is defined as countercyclical.

[2] Our approach is closest to Jordà et al. (2020), which also use instrumental variables and local projection methods to study the impact of monetary shocks for a set of advanced economies by employing the policy trilemma. However, our historical laboratory permits us to identify two sources of exogenous variation, allowing us to focus on a different set of questions – policy evaluation of *countercyclical* monetary shocks – and our data set allows us to consider these effects on *developing* and *advanced* economies. Specifically, we collect data on interest rates for a panel of 40 economies, a superset of the previous work including many emerging economies, but focus on a shorter period than their research, 1870-1913, so that we can analyze causal countercyclical monetary shocks.

Our results establish that countercyclical interest rates undo the effects of export-price shocks on real GDP per capita and on the domestic price level. Using our IV approach, when base-country (UK) interest rates are countercyclical to country-specific export price shocks, the effect of export-price shocks on real GDP is close to zero at all horizons. On the other hand, it approaches 2 percent after five years when interest rates are either procyclical or acyclical. This stabilization effect also occurs for the price level. Domestic prices are again virtually unchanged under countercyclical interest rates. However, the price level increases substantially when rates are procyclical or acyclical, 4 percent higher after four years.

These results complement existing structural work on monetary policy for open economies (Gali and Monacelli, 2005; Catão and Chang, 2013; Catão and Chang, 2015 and Vogel et al., 2015).[3] They are particularly relevant for commodity exporters, which often peg their currencies, therefore relinquishing monetary policy under capital mobility, and which have recently experienced increased volatility in commodity prices (Frankel, 2010; and Frankel, 2017). Finally, our results provide empirical evidence that is grounded on causal identification for state-dependent effects of monetary shocks, and thus complement previous research measuring the state of the economy using output gaps or real GDP growth (Alpanda et al., 2021; Jordà et al., 2020; Tenreyro and Thwaites, 2016; Weise, 1999). Given the nature of the shocks considered, our results are most relevant for emerging economies that are commodity exporters.

[3] Our paper is also related to the literature studying the role of pegs and exchange-rate regimes on macroeconomic adjustment following terms of trade shocks. For example, Levy-Yeyati and Sturzenegger (2003) and Broda (2004) provide empirical evidence that terms of trade shocks have a larger effect on economic performance in economies with more rigid exchange-rate regimes than in economies with flexible exchange rate regimes.

2. Data and Empirical Framework

Our sample period, 1870-1913, is crucial for identification. That is, several features of the global economy and policy making during this earlier era provide a near perfect laboratory for identifying exogenous shocks, which can then be used to evaluate the causal effects of countercyclical interest-rates. First, declining trade barriers in the middle of the 19th century and rapidly falling transportation costs throughout the century led to an explosion in global trade and a free flow of goods across borders (O'Rourke and Williamson 1994, 1999). This feature of the so-called first era of globalization allows us to examine economies dependent on trade. Second, our sample period, 1870-1913, corresponds to the classical gold standard era – when economies increasingly pegged their exchange rates to gold. As a result, economies with currency pegs were exposed to monetary shocks emanating from the "base" economy – in this era, the United Kingdom – and these pegs committed domestic policy makers to respond to base-country interest-rate changes to maintain their fixed exchange rates (Bordo and Rockoff, 1996).

Furthermore, unlike the interwar period or the rest of the 20th century, capital flowed without restriction: economies maintained pegged exchange rates without the use of capital controls (Obstfeld and Taylor, 2001). According to the international macroeconomics policy trilemma, a country cannot simultaneously achieve fixed exchange rates, capital mobility, and monetary policy independence. Given that many economies in this period were pegging to gold and permitted the free movement of capital, interest-rate movements in the UK, the largest economy at the time, thus provide a source of exogenous variation in domestic monetary conditions (Obstfeld et al., 2005 and Jordà et al., 2020). Third, most economies produced goods that were "pre-determined" in the sense that they specialized in producing goods and commodities based on factor endowments (geography and climate) and were thus subjected to what economic historians refer to as the "commodity lottery" (Blattman et al., 2007; Findlay, 2003; O'Rourke and Williamson, 1994). Because these products represented a large share of production and trade, changes to export prices significantly influenced income in these economies. Fourth, external-demand shocks emanating from changes in export prices aree plausibly exogenous. That is, export prices were largely determined in global markets, and given that goods markets were highly integrated in this period, "commodity lottery" economies were largely price takers.

2.1. Data

To analyze the causal effects of export shocks and interest-rate shocks on macroeconomic performance, we construct a new data set spanning 1870-1913. To measure exogenous real shocks to economies, we collected new data on economies' principal exports from 1870-1913. We identify the principal exports for each economy by constructing export weights using primary sources (*British Board of Trade*, various years) and secondary sources (Jacobson, 1909; Mitchell, 1982, 2007a, 2007b). Appendix A provides detailed information on the sources and the methods used to determine the principal export for each economy. We use the largest, single principal export for each country (by value), as in Caselli and Tesei (2016), in order to ensure that our identified shock is both exogenous and an important determinant of economic conditions.

We then combine this information with data on prices for exported goods collected by Blattman et al. (2007), and which covers all the economies in our sample at the annual frequency. To measure interest-rate shocks, we employ data on short-term interest rates from Neal and Weidenmier (2003). These rates represent either a country's open market rate or its discount rate; they are denominated in domestic currency, are highly liquid, and are not subject to default risk (Mitchener and Weidenmier, 2015). They are therefore a crucial determinant of credit conditions in domestic markets. For economies lacking interest rates from these sources, we use interest rates on short-term government bonds from Jordà et al. (2015) as well as country-specific sources described in Appendix C. To measure macroeconomic performance, we utilize estimates of annual real per capita GDP compiled by Barro and Ursúa (2010). Inflation rates are from Jordà et al. (2015) and Reinhart and Rogoff (2011). Additional data for these two macroeconomic variables are from Maddison (2013) and Pisha et al. (2015).[4]

[4] We construct indices for domestic prices using the inflation rate data and indices for real GDP per capita when source data on a country's real GDP per capita is only given in percentage changes. We also drop Greece and Bulgaria from the GDP sample in 1913 to correct for the large increase in population following the annexation of territories as part of the First Balkan War.

These sources and newly collected data permit the construction of an unbalanced panel of 40 economies that includes developing economies as well as the more advanced ones (industrial economies of the late-19th and early-20th centuries).[5] Table 1 displays summary statistics of the main variables. The binding constraint for our analysis of countercyclical interest rates is the availability of short-term domestic interest rates, which are available, historically, for 30 economies. From this set of economies, we use the United Kingdom (UK) as the base economy for our sample periods, which researchers view as centrally important to the operation of the classical gold standard (Bloomfield, 1959). A set of 38 economies formally adhered to the gold standard for at least one year in our sample. The intersection between data on principal export prices, outcome variables, gold standard adoption, and short-run domestic interest rates allows us to analyze the effects of countercyclical domestic interest rates for 26 economies.[6]

Table 1: Summary statistics, 1870-1913.

	Observations	Mean	Std. Dev.	Min	Max
Real GDP per capita	1,719	1.2	6.1	-36.4	38.8
Domestic price level	1,589	0.7	7.5	-35.5	76.0
Deflated principal-export prices	1,560	-0.6	11.2	-40.6	53.2
Annual interest rate (in basis points)	1,100	497	186	106	1424
Change in annual interest rate (in basis points)	1,065	-0.0	79	-1081	586

Note: The series displayed in the first three rows are computed as one-year log differences (times 100) and should therefore be interpreted as growth rates.

[5] The panel is unbalanced due to differential adherence to the gold standard and, to a lesser extent, data availability.

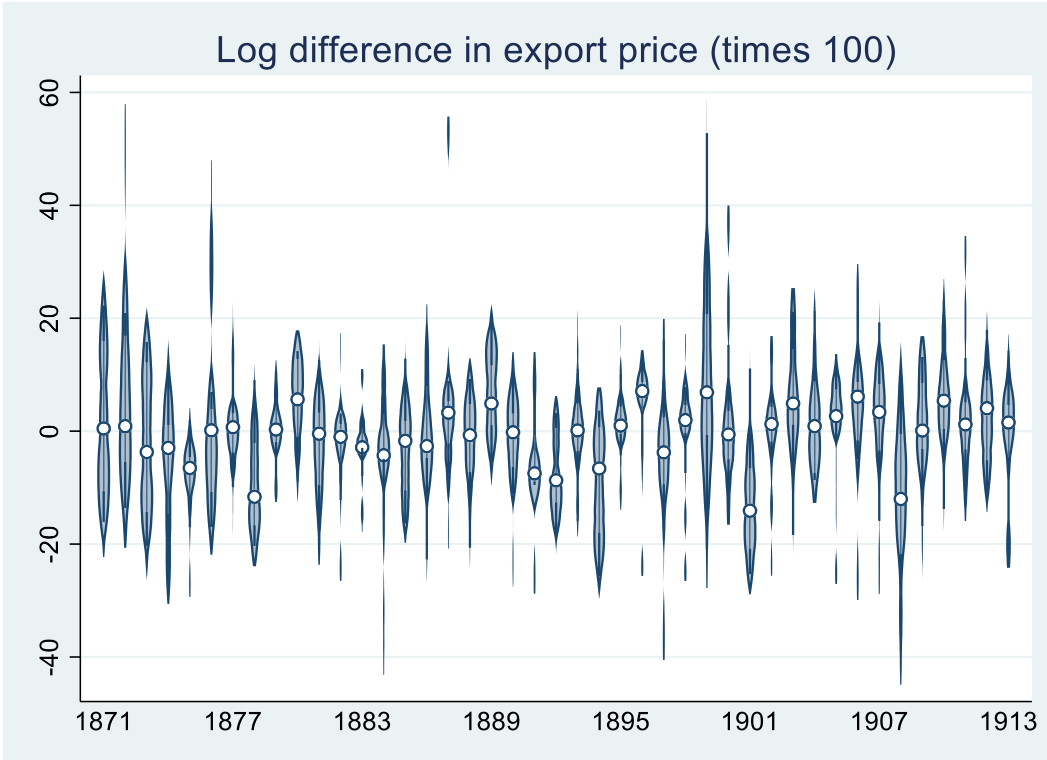
[6] Appendix Table 1 provides information on data availability and variables including the principal export for each economy. For 38 economies that adhered to the classical gold standard, we have data on outcomes and export-price shocks, but not domestic interest rates, which still allows us to run the IV reduced form specification in a robustness check, and study the direct effect of countercyclical base country interest rates in these economies. For one economy, we have data on domestic interest rates but this economy did not join the classical gold standard. We use data for economies while they are not adhering to the classical gold standard in placebo tests. We omit France and Germany from the analysis as our assumptions of exogeneity of exports and interest rate shocks are less likely to hold for these two countries.

2.2. Identifying Export and Interest-Rate Shocks

To estimate causal effects, we identify plausibly exogenous sources of variation in export prices and interest rates. We define the shock to export prices as changes in the log difference in the real principal-export price, which is obtained by deflating nominal export prices using a price index for manufacturing goods. In economies that are dependent on trade, fluctuations in principal export prices are crucial determinants of income. Our identified export-price shock is plausibly exogenous under two identifying assumptions. First, prices for these goods are exogenous to shocks in the economies producing them. Second, the specialization pattern is also exogenous with respect to the interest-rate and price shocks that we identify. Both assumptions are likely to hold in our sample. For most economies, the principal export is a commodity, produced in a variety of locations around the globe, each with similar, pre-determined factor endowments. Prices for these commodities were determined in global markets (see Blattman et al., 2007) and commodity producers were, for the most part, price takers (Williamson, 2013). For a small number of economies in our sample, the principal export is a manufacturing product. However, adjustment costs in production limit the ability of economies to respond to shocks in the short run. Furthermore, as we show in additional specifications, our results are robust to including only commodity exporters. To sum up, fluctuations in an economy's principal exports provide a plausibly exogenous source of variation for measuring income shocks.

Appendix Table 2 illustrates the wide variation in types of goods exported. Since a few commodities were produced by (near) monopolists, we consider these exceptions to our "price-taker" assumption in robustness checks. To identify meaningful external shocks that are country-specific, the price data need to exhibit sufficient variation. Figure 1 displays kernel density functions of the annual percentage change in commodity prices for each year in our sample. These plots show substantial cross-sectional and time-series variation in export-price shocks. The white dot represents the median for each year. The spikes represent extreme values by year. We also plot the probability density for each year, smoothed by the Epanechnikov kernel. For example, in 1871, the year shown in the graph, export-price shocks range from -20% and 20%, with higher density slightly below 0%.

Figure 1: Kernel Densities by year of Export Price Shocks



Note: Export-price shocks are defined as the log difference in the deflated export price. For each year, the white marker represents the median, while the spikes represent extreme values. Kernel densities are estimated using the Epanechnikov kernel function.

We now turn to identifying interest-rate shocks. Since there were no restrictions on the movement of capital during our sample period (i.e., no capital controls) and fixed exchange rates were widely used during the classical gold standard era, the international policy trilemma implies that when interest rates change in the base economy, other economies will respond by altering their own interest rates, either formally through a policy rate controlled by a central bank (in economies where they existed) or, in their absence, through a no-arbitrage condition in financial markets. We use this insight to formulate a third identifying assumption – that from 1870-1913, interest rates in the UK (which Keynes (1930) called the "conductor of the international orchestra") influenced the interest rates of other economies formally on the gold standard.[7]

We define an interest-rate shock as:

(1) $$\boldsymbol{R_{i,t}} = \left(\Delta \boldsymbol{i_{UK,t}} - \Delta \boldsymbol{i^{*}_{UK,t}}\right) \times \boldsymbol{Peg_{i,t}},$$

where $\Delta i_{UK,t}$ is the change in the interest rate in the UK and $\Delta i^{*}_{UK,t}$ is the change in the interest rate in the UK predicted by observable domestic variables and by global factors capturing the global business, commodity, and financial cycles.[8] The variable $Peg_{i,t}$ takes on a value of 1 if a country formally adheres to the gold standard and zero otherwise. Intuitively, the instrument captures changes in the interest rate of the base country, the United Kingdom, which are not explained by that country's observable economic conditions or global factors. Controlling for these factors has an impact on estimated shocks. The correlation between the estimated interest-rate shock and raw interest-rate movements is equal to 0.61.

In principle, it would be possible to use our identification strategy to examine other historical eras or more recent periods; however, if the researcher's goal is to generate causal estimates of countercyclical interest rates, there are considerable challenges to changing the sample period. First, as noted earlier, this earlier era of globalization, defined to a large extent by trade in commodities, is particularly well suited to the identification of exogenous demand shocks. Second, including the interwar period, the Bretton Woods era, or the early 1970s would require that we incorporate capital controls into the analysis, given their widespread usage in those periods. Since we are interested in

[7] A classic reference is Bloomfield (1959). For more recent treatments, see also Obstfeld, Shambaugh, Taylor (2005) and references therein. Potentially, the UK also influenced interest rates in economies using other types of fixed exchange-rate arrangements, such as economies on silver, bimetallism, or "shadowing" the gold standard.

[8] We measure global real GDP per capita growth using Maddison (2013) and deflate the price index of UK imports by UK domestic prices using data available in Jordà et al. (2015). In our baseline specification, we include the contemporaneous effect and one lag of the first difference in log real GDP, log UK prices, log UK deflated import prices, log of global real GDP per capita and a dummy variable capturing global financial crises, as well as one lag of the UK interest rate. These are estimated within our sample, 1870-1913. In robustness checks we use also data for the interest-rate shock directly from Jordà et al. (2020), which are estimated using a larger sample, and highly correlated with the raw changes in UK interest rates between 1870-1913 (the correlation coefficient equal to 0.92).

explaining short-term macroeconomic responses, doing so would require careful measurement of annual changes in capital controls such that the researcher could discern when barriers on the flow of the capital were being used to offset or counteract interest-rate changes in a base country's rate. It is far easier (and hence more common in the literature) to define capital controls in terms of "regimes," using indicator variables that indicate their de jure or de facto existence, then it is to measure precise *changes* to controls once they exist. This measurement issue makes the instrumental variables approach used in our paper to identify causal estimates quite challenging to implement for more recent sample periods.[9] Third, because policy makers in the late 19th and early-20th centuries were strongly committed to maintaining the gold standard and external balance (Bordo and Kydland, 1995), we can focus on measuring the effects of countercyclical monetary shocks without being concerned about the simultaneous use of fiscal policy. For example, in a simple Mundell-Flemming model, fiscal policy can be quite effective for a small, open economy with a fixed exchange rate and no capital controls. After World War I, policymakers became more responsive to internal balance due to domestic political considerations and fiscal policy became a more widespread tool for demand management (Eichengreen, 1998); hence, any estimation in later eras would need an empirical strategy that accounted for and credibly identified fiscal policy shocks.[10]

Table 2 displays the contemporaneous "pass through" from the instrumental variable to domestic short-term interest rates. The coefficient is positive and significant: a one-percentage-point exogenous increase in the UK interest rate leads to a contemporaneous increase in domestic rates

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[9] For example, see the use of intermediate measures, such as partial capital controls or limited exchange-rate flexibility, in the wake of the Great Recession (Klein and Shambaugh, 2015).

[10] It is worth pointing out key differences in our samples, central questions, and identifying assumptions relative to Jordà et al (2020), which employ a similar approach for identifying interest-rate shocks. First, our primary objective is to provide credible estimates of *countercyclical* shocks, a question not addressed in their research and that may be especially important for emerging market economies that are often quite reliant on exports for growth (Mendoza, 1997 and Blattman et al, 2007). Because we collect data and estimate export-demand shocks, we can estimate the effect of countercyclical monetary shocks. Second, we collected data on interest rates for a panel of 30 economies plus the UK; this is a superset of their analysis for 17 developed economies. Our sample includes many more emerging-market economies, allowing us to test hypotheses that may be of particular importance to developing economies. Third, we primarily use discount rates (the policy rate used by gold standard economies in the classical gold standard era) and market short-term interest rates to measure monetary policy instead of rates obtained from short-term government bonds. Finally, we focus exclusively on the classical gold standard era, a period that provides clean identification for reasons noted above.

of about 0.3 percentage points.[11] We include only observations for economies while adhering to the classical gold standard, which will be the relevant sub-sample for our countercyclical interest-rate exercises.

Table 2: Relationship between the Instrumental Variable and Domestic Interest Rates

Coefficient	(1)	(2)	(3)
Instrument R	0.302***	0.309***	0.293***
	(0.055)	(0.057)	(0.050)
Country Fixed Effects		X	X
Controls			X
Economies	28	28	28
Observations	676	676	674

Notes: The dependent variable is the change in the nominal interest rate for country i, at time t. The trilemma instrument is defined in equation (1). Control variables are all included as contemporaneous and one-year lag values. Controls include: international financial crisis dummy, domestic financial crisis dummy, world growth and inflation in the UK, both defined as the log difference times 100. Robust standard errors, clustered at the country level, are in parentheses. Regressions include only observations for economies while adhering to the classical gold standard. *** denotes significance at the 1% level, ** denotes significance at the 5% level, and * denotes significance at the 10% level.

Table 3 provides a placebo test for the identification of interest-rate shocks by examining observations for all economies that are not on the gold standard during our sample period. As displayed in Appendix 1, there is variation both in terms of the economies that adhere to the classical gold standard and the times of adherence. Consistent with our identifying assumption for interest rates, the result in the table shows that there is no statistically significant relationship between changes in UK interest rates and domestic interest rates when we restrict the sample to non-gold-standard observations.

[11] The gold standard allowed for deviations from complete pass through. These deviations occurred due to limits to arbitrage related to the cost of financing, insuring and transporting gold. In other words, exchange rates were fixed within a band, the gold points. See Hallwood et al. (1996) for an interpretation of the gold standard as a target zone and Krugman (1991) for a model of target zones that is consistent with positive, but imperfect, pass-through in defense of the exchange rate even if it lies inside the target zone.

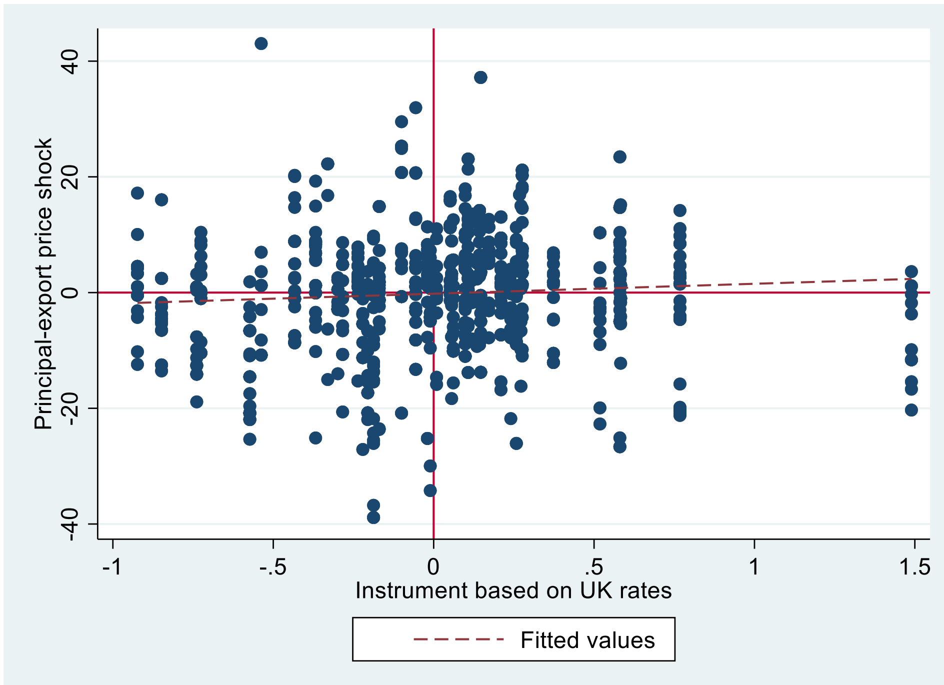
Table 3: Placebo relationship between Instrumental Variable and Domestic Interest Rates

Coefficient	(1)	(2)	(3)
Instrument R (Placebo)	-0.027	-0.031	-0.026
	(0.111)	(0.116)	(0.120)
Country Fixed Effects		X	X
Controls			X
Economies	25	25	24
Observations	346	346	331

Notes: The dependent variable is the change in the nominal interest rate for country i, at time t. The trilemma instrument is defined in equation (1). Control variables are all included as contemporaneous and one-year lag values. Controls include: international financial crisis dummy, domestic financial crisis dummy, world growth and inflation in the UK, both defined as the log difference times 100. Robust standard errors, clustered at the country level, are in parentheses. Regressions include only observations for economies while not adhering to the classical gold standard. *** denotes significance at the 1% level, ** denotes significance at the 5% level, and * denotes significance at the 10% level.

If both export-price and the interest-rate shocks are exogenous, then the joint distribution of shocks is determined by a process that resembles random assignment, and consequently our empirical design is one of a quasi-natural experiment. Since we are ultimately interested in identifying the effects of combinations of the shocks for a given country, the two types of shocks should not be highly correlated. In other words, substantial exogenous variation in the joint distribution of export-price and interest-rate shocks is desirable. Figure 2 shows that the correlation between export-price shocks and changes in UK interest rates is relatively low. Given our focus on the countercyclical exercises, Figure 2 plots only observations for which economies formally adhere to the gold standard at time t. The unconditional correlation coefficient between the instrument $R_{i,t}$ and the principal export-price shock is 0.09. More importantly, there is substantial variation in the joint distribution of shocks. Note that the instrument, the base rate change conditional on UK domestic factors and global factors, is a common shock. For example, consider the lowest estimate for $R_{i,t}$, which is about -100 basis points. This represents a decrease in interest rates and a loosening of credit conditions. The values for the export-price shock range between -15% and 20%. Overall, for a given interest-rate shock, there is substantial variation in the percentage change in real principal export prices, including some economies with positive shocks and others with negative shocks.[12]

Figure 2: Correlation between export-price shocks and interest-rate shocks



Notes: The figure shows the relationship between export-price shocks and interest rates conditional on an economy formally adhering to the gold standard at time t. Export price shocks are in percentage changes and interest rates are in changes.

3. Econometric Approach

Our estimation begins by examining the effects of export-price and interest-rate shocks on real GDP and domestic prices using Jordà's (2005) local projections method. We estimate impulse response functions by computing responses to a shock at t, measured over different horizons h, where the initial impact is defined as $h=0$, the cumulative one-year impact as $h=1$, and so forth. Using local projections allows us to impose fewer constraints on impulse response functions compared to

[12] Appendix Table 1 displays within-country correlation coefficients for the two shocks.

VARs, to include instrumental variables, and to estimate the average treatment effect of shocks given country heterogeneity.[13]

The first approach is to estimate the effect of export-price shocks, taking other variables as given. That is, we run the following specification at different horizons, *h*:

$$y_{i,t+h} = \alpha_{i,h} + \rho_h y_{i,t-1} + \beta_h p_{i,t} + \gamma_h p_{i,t-1} + \varepsilon_{i,t+h}, \quad (2)$$

where $y_{i,t+h}$ represents either real GDP or the domestic price level country in *i,* both in log-differences, at each horizon *h* and time *t.* A contemporaneous export shock, $p_{i,t}$, as well a one-period lagged shock are included. The model also includes, $\alpha_{i,h}$, a country-fixed effect. Standard errors are clustered at the country level.[14]

Under the assumption that export-prices are exogenous, this equation estimates the cumulative causal impact of export-prices on real GDP or CPI prices at each horizon. The parameter, β_h, captures the effect of an increase in export prices equal to 1 percentage point on either real GDP or the price level after *h* years. Available data in our panel allows us to estimate this regression for 38 economies for real GDP and for 31 economies for the price level.

We next augment equation (2) and include the change in the domestic interest-rate, defined as $\delta_{i,t}$. In particular, we estimate the following equation:

$$y_{i,t+h} = \alpha_{i,h} + \rho_h y_{i,t-1} + \beta_h p_{i,t} + \gamma_h p_{i,t-1} + \omega_h \delta_{i,t} + \tau_h \delta_{i,t-1} + x_{i,t}\theta_h + x_{i,t-1}\mu_h + \varepsilon_{i,t+h}, \quad (3)$$

where the estimand $\boldsymbol{\omega_h}$ captures the correlation between changes in domestic short-run interest rates and economic outcomes at different horizons. The vector $x_{i,t}$ collects global and domestic time-varying controls. These include the log difference of world real GDP per capita, the inflation rate in the UK, an international financial crisis dummy, and a domestic financial crisis

[13] Plagborg- Møller and Wolf (2021) show that, without imposing restrictions on the lag structures, linear local projections and Vector Autoregressions (VARs) estimate the same impulse response functions. We follow standard practice in local projections approaches and include one-lag for dependent and independent variables in all regressions.

[14] We follow Jordà et al. (2020) and do not include time fixed effects. Given that all economies are exposed to the same interest-rate shock, we cannot estimate time-fixed effects separately in the countercyclical exercises. Instead, we control for the world economic cycle directly, using GDP growth, UK inflation rates, and global financial crises.

dummy. These capture global factors in GDP, prices, and the financial cycle as well as domestic financial crises. The lack of domestic interest rate data for some economies constrains the sample to 26 economies.

To address the concern that domestic interest rates are endogenously determined together with output and the price level, we use the instrumental variables approach described in Section 2 to obtain an instrument for domestic interest-rate changes. For economies that formally adhere to the classical gold standard, the instrument is changes in UK interest rates that are not explained by UK and global observable variables.

As described in Section 2, the identifying assumptions are that estimated interest-rate shocks are: (1) as good as randomly assigned; (2) affect the "treated" or non-base economy only through their effects on the domestic interest rate; and (3) the instrument affects the endogenous regressor, i.e., the change in the domestic interest rate. The role of the UK economy in the classical gold standard suggests that assumption (1) is likely to hold since economic conditions in a particular emerging economy do not determine estimated UK interest-rate shocks. Note that we strip out the portion of a given change in the UK interest rate from changes explained by domestic UK economic variables as well as by global GDP growth, world commodity prices, and world financial crisis. Assumption (2) is the exclusion restriction. Although it is reasonable to expect that the main channel through which changes in UK rates affect other economies is through their effect on domestic interest rates, we cannot test this condition directly; however, we introduce a set of global and domestic controls that may address potential alternative channels. Finally, table 2 shows that assumption (3) holds. Estimated interest-rate shocks in the UK are strongly correlated with domestic interest-rate movements for economies adhering to the classical gold standard. Table 3 shows that this relationship is only present for economies adhering to the classical gold standard.

Armed with this instrument, we estimate:

(4) $$y_{i,t+h} = \alpha_{i,h} + \rho_h y_{i,t-1} + \beta_h p_{i,t} + \gamma_h p_{i,t-1} + \omega_h \hat{\delta}_{i,t} + \tau_h \delta_{i,t-1} + x_{i,t}\theta_h + x_{i,t-1}\mu_h + \varepsilon_{i,t+h},$$

where $\hat{\boldsymbol{\delta}}$ corresponds to the predicted values for the change in the domestic interest rate, obtained from the following first-stage regression:

(5) $$\delta_{i,t} = a_i + b_1 y_{i,t-1} + b_2 p_{i,t} + b_3 p_{i,t-1} + b_4 R_{i,t} + b_5 \delta_{i,t-1} + x_{i,t} c + x_{i,t-1} d + \varepsilon_{i,t}\,.$$

The coefficient $\boldsymbol{\omega_h}$ captures the causal effect of a change in the domestic interest rate on real GDP and the price level at different horizons h, where the domestic interest rate is instrumented using *R*.

Finally, the main contribution in this paper is to estimate equations (4) and (5) for different sub-samples that capture whether interest rate movements in the UK are countercyclical or procyclical/acyclical with respect to country-specific export-price shocks. We define countercyclical interest-rates as periods when: (1) the export price shock is below the average of the period and the interest-rate shock is negative or (2) the export price shock is above the average in the period and the interest-rate shock is positive. We compare these episodes to all others, including procyclical and acyclical policy periods. Crucially, these countercyclical dummies are built using the variable, *R*. That is, they are based on the source of the exogenous UK interest rate shock, not the domestic interest-rate response.[15]

[15] We opt to use the sample average as the cutoff level for export prices for two reasons. First, the average growth rate of deflated export prices is negative in our sample. As many of the exports are commodities, this is consistent with the Prebisch-Singer hypothesis (see Harvey et al. 2010 for a recent review). Second, one empirical challenge in our exercise is to have enough observations in the different sub-samples to estimate the relevant parameters in each scenario. Using the average ensures a more balanced distribution of observations which facilitates the estimation of the parameters. Results using zero as a cutoff are similar but have lower first stage F-statistics.

4. The economic effects of export-prices and interest rates

To analyze the causal effects of countercyclical interest rates, our empirical research design requires two exogenous shocks: (1) global-price shocks that affect aggregate income through the value of exports and (2) base-country (UK) interest-rate shocks that shift interest rates for other (non-UK) economies adhering to the gold standard. Before estimating the effects of countercyclical interest rates, this section reports results supporting these two channels and provides evidence for the unconditional effects of export-price shocks and interest rates. These results are interesting in their own right. As discussed in the introduction, the effect of export-price shocks is related to the short- and medium-run macroeconomic effects of commodity shocks, which have been studied for other eras, but not during the classical gold standard. Moreover, the macroeconomic effects of interest-rate shocks have been studied for emerging economies after World War II, as well as for the sub-sample of more developed economies between 1870 and World War II, but not for the emerging economies we consider in the classical gold standard period.

Table 4 displays the results for the regression defined by equation (2), which estimates the effect of export-prices on real GDP and on the price level, taking interest rates as given. It shows that output and prices respond positively to export-price shocks. Table 4 shows results for economies formally adhering to the classical gold standard – the sample used in the countercyclical exercises presented later in the paper. However, results for the full available data show a similar relationship between export-price shocks and macroeconomic aggregates.

We use impulse response functions to illustrate the short-run response of the economy to shocks. The solid black lines in figure 3 display the effects following a one-standard-deviation increase in deflated principal-export prices, with 90% confidence intervals shown by dashed lines. The results show that the effect of export prices is positive on both real GDP and the price level, but that it is stronger and more finely estimated for the price level than for real GDP.

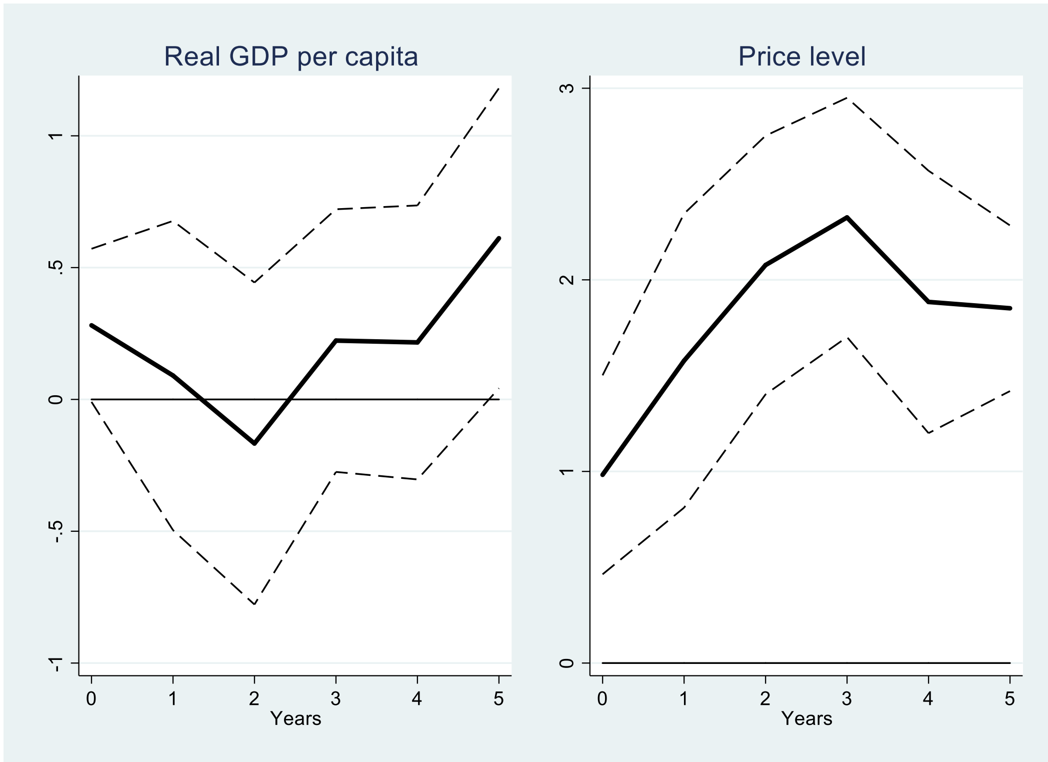
Table 4: Local Projections Estimates for the Response of Real GDP per Capita and the Price Level to Export-Price Shocks

Responses at years 0 to 5 (100 x log change from baseline)

	Log change export-price	
Year after shock	Real GDP	Price Level
h=0	0.025	0.087***
	(0.016)	(0.028)
h=1	0.008	0.140***
	(0.032)	(0.041)
h=2	-0.015	0.184***
	(0.033)	(0.036)
h=3	0.020	0.206***
	(0.027)	(0.036)
h=4	0.019	0.167***
	(0.028)	(0.037)
h=5	0.054*	0.164***
	(0.031)	(0.023)
Number of economies	38	31
Observations at h=0	898	812

Notes: The dependent variable is defined as either real GDP per capita or the price Level (100 x log change from baseline). The independent variable is 100x the log change of the principal export-price. LP-OLS estimates are obtained using equation (2), using observations of countries adhering to the gold standard. All regressions include country fixed effects, as well as one lag of the dependent and the independent variables. *** p<0.01, ** p<0.05, * p<0.1. Clustered standard errors by country are shown in parentheses.

Figure 3: Local Projections Estimates for the Response of Real GDP per Capita and the Price Level to Export-Price Shocks



Notes: Real GDP per capita (left panel) and price level (right panel) response to a one-standard-deviation increase in the log change of real principal-export prices. All panels show results from the estimation outlined in equation (2). Only observations for economies adhering to the classical gold standard are used. LP-OLS estimates displayed with solid black lines and 90% confidence bands as dashed lines.

Table 5 shows the results including the change in domestic interest rates, as defined by equation (3). The two left columns in the results in table 5 show the effects of export-price shocks on the macroeconomic aggregates. The two right columns report the effects of the change in domestic interest rates. Results are more clearly visualized in figure 4, which plots the impulse responses. The top panels in figure 4 show the results for export-price shocks. The bottom panels display the effect of a domestic interest-rate shock, following a one-standard-deviation increase in UK interest rates. Confidence intervals are shown with dashed lines.

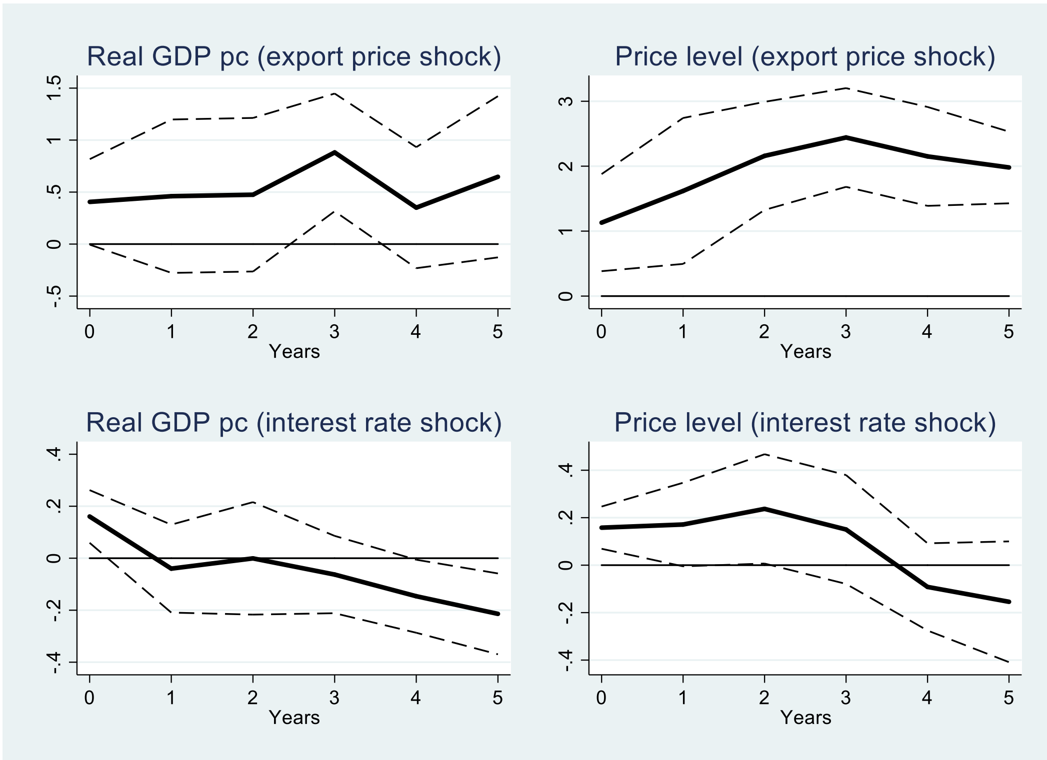
Table 5: Local Projections Estimates for the Response of Real GDP per Capita and the Price Level to Export-Price and Interest-Rate Shocks

Responses at years 0 to 5 (100 x log change from baseline)

	Log change export-price		Change in domestic interest rate	
Year after shock	Real GDP	Price Level	Real GDP	Price Level
h=0	0.036	0.099**	0.630**	0.620***
	(0.022)	(0.040)	(0.242)	(0.212)
h=1	0.040	0.142**	-0.157	0.672
	(0.039)	(0.060)	(0.403)	(0.420)
h=2	0.042	0.190***	-0.002	0.930
	(0.039)	(0.044)	(0.516)	(0.549)
h=3	0.077**	0.215***	-0.246	0.590
	(0.030)	(0.041)	(0.355)	(0.547)
h=4	0.031	0.189***	-0.574*	-0.360
	(0.031)	(0.041)	(0.335)	(0.438)
h=5	0.057	0.174***	-0.840**	-0.605
	(0.041)	(0.029)	(0.371)	(0.607)
Number of economies	26	26	26	26
Observations at h=0	584	589	584	589

Notes: The dependent variable is defined as either real GDP per capita or the price Level (100 x log change from baseline). The independent variables are 100x the log change of the principal export-price and the change in the domestic interest rate. LP-OLS estimates are obtained using equation (4), using observations of countries adhering to the gold standard. All regressions include country fixed effects and world real GDP per capita growth, UK inflation rate, and dummy variables for international and domestic financial crises, contemporaneously and with one lag, as well as one lag of the dependent and the independent variables. *** p<0.01, ** p<0.05, * p<0.1. Clustered standard errors by country are shown in parentheses.

Figure 4: Local Projections Estimates for the Response of Real GDP per Capita and the Price Level to Export-Price and Interest-Rate Shocks



Notes: Real GDP per capita (left panel) and price level (right panel) response to a one-standard-deviation increase in the log change of real principal-export prices. All panels show the baseline model including global and country-specific controls, $x_{i,t}$. Only observations for economies adhering to the classical gold standard are used. LP-OLS estimates displayed with solid black lines and 90% confidence bands as dashed lines.

As the top panels in figure 4 show, the results for export-price shocks for the subsample for which we have data on domestic rates are similar to the results for the larger sample where we do not use domestic rates. Both real GDP and the price level increase following a positive export-price shock. The bottom panels show a positive correlation between interest rate increases and real GDP per capita and the price level on impact, and a null correlation for both variables between horizons one to three. This correlation turns negative from horizon four until five, although this latter effect is only estimated finely for real GDP.

Upon initial observation, the correlation between domestic interest rates with real GDP and the price level may seem puzzling. However, note that domestic interest rates are likely endogenous to local and global economic conditions. Therefore, OLS estimates may be biased, providing motivation for our instrumental variables specification, which we now consider.

Table 6 presents the causal effects of domestic interest-rates, instrumented by UK rates, together with export-price shocks. Given that these two shocks are uncorrelated, the reported results for export prices should again not change relative to the ones in tables 4 and 5. To account for potential alternative mechanisms affecting both UK rates and domestic interest rates, we include controls for global and domestic time-varying factors – the log difference of world real GDP per capita, the inflation rate in the UK, an international financial crisis dummy variable, and a domestic financial crisis indicator variable.

The two left columns show that output and prices respond positively to the export-price shock, similar to before. The two right columns show that the response to the interest-rate shock is negative. The first-stage F-stats are relatively large. The Kleibergen-Paap Wald F-statistic is above 30 in the real GDP regressions, and above 25 in the price level regressions. The findings show that increases in the domestic interest-rate cause a reduction in output and prices in economies that adhered to the gold standard – a result that differs from the OLS results shown in table 3 and figure 4, which did not correct for endogeneity bias.[16]

The top left panel of figure 5 shows that a one-standard-deviation increase in deflated principal export prices (equivalent to an 11% increase) raises real GDP per capita by about 0.5 percent. However, this effect is not significantly different from zero at conventional levels. The bottom left panel of figure 5 shows that an increase in domestic short-term interest rates following a one-standard-deviation increase in UK rates (approximately 25 basis points) causes real GDP per capita to decrease by 1 percent. The right panels of figure 5 show that the effects are stronger for the price level. The top right panel shows that a one-standard-deviation increase in the economy's principal export price leads to an increase in domestic prices levels by 1.5 percent after four years. The bottom right panel shows that, following a one-standard-deviation increase in interest rates, prices decline by roughly 2.5 percent after five years.

[16] The p-values for the Hausman test at horizon zero that the OLS estimates are equal to the IV estimates equal to 0.067 for the real GDP regression, and 0.001 for the price level regression.

Table 6: Local Projections Instrumental Variables Estimates for the Response of Real GDP per Capita and the Price Level to Export-Price and Interest-Rate Shocks

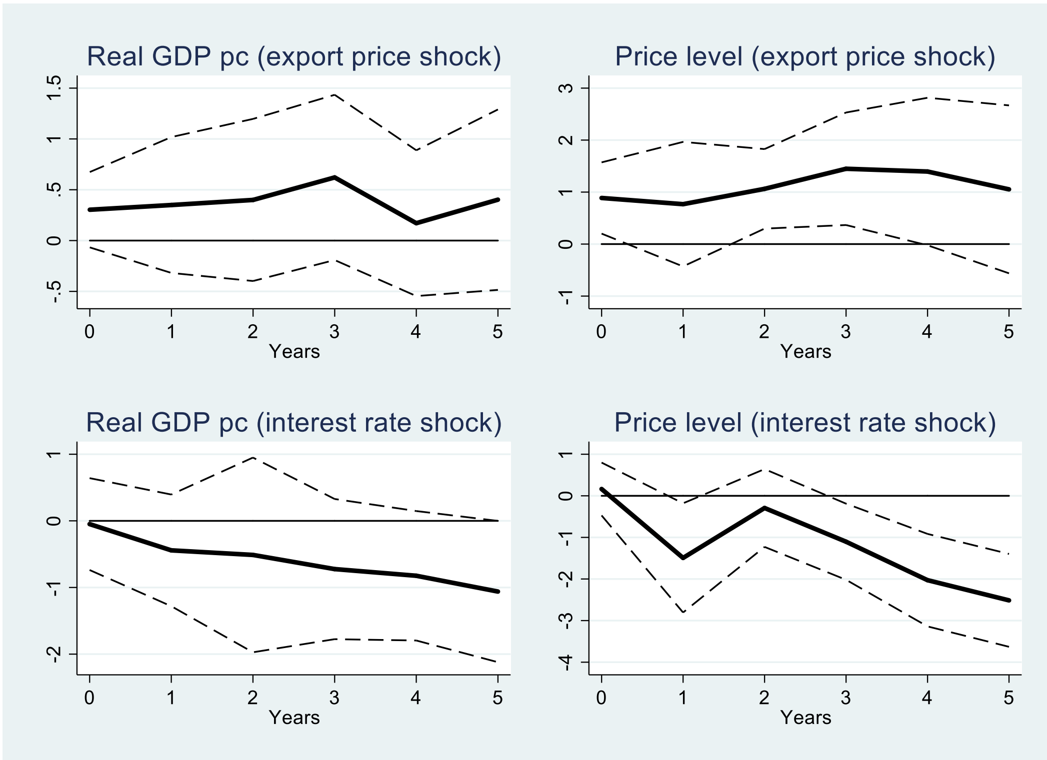
(Domestic rates instrumented by R)

Responses at years 0 to 5 (100 x log change from baseline)

	Log change export-price		Change in domestic interest rate	
Year after shock	Real GDP	Price Level	Real GDP	Price Level
h=0	0.026	0.078**	-0.029	0.331
	(0.020)	(0.037)	(1.842)	(1.644)
h=1	0.031	0.064	-1.485	-7.305*
	(0.036)	(0.069)	(2.248)	(3.886)
h=2	0.036	0.091**	-1.567	-1.788
	(0.041)	(0.041)	(3.760)	(2.485)
h=3	0.054	0.125**	-2.488	-5.558**
	(0.042)	(0.063)	(2.824)	(2.820)
h=4	0.015	0.121	-2.970	-9.435***
	(0.037)	(0.084)	(2.545)	(3.553)
h=5	0.037	0.090	-4.026	-12.050***
	(0.048)	(0.100)	(2.703)	(3.605)
Kleibergen-Paap F-stat	33.0	25.8	33.0	25.8
Number of economies	26	26	26	26
Observations at h=0	582	587	582	587

Notes: The dependent variable is defined as either real GDP per capita or the price Level (100 x log change from baseline). The independent variables are 100x the log change of the principal export-price and the change in the domestic interest rate, instrumented by R as defined in equation (1). LP-IV estimates are obtained using equation (6), using observations of countries adhering to the gold standard. All regressions include country fixed effects and world real GDP per capita growth, UK inflation rate, and dummy variables for international and domestic financial crises, contemporaneously and with one lag, as well as one lag of the dependent and the independent variables. *** p<0.01, ** p<0.05, * p<0.1. Clustered standard errors by country are shown in parentheses.

Figure 5: Local Projections Instrumental Variables Estimates for the Response of Real GDP per Capita and the Price Level to Export-Price and Interest-Rate Shocks



Notes: Real GDP per capita (left panels) and price level (right panels) response to a one-standard-deviation increase in the log change of real principal-export prices (top panels) and to a one-standard deviation increase in the interest rate (bottom panels). All panels show the baseline model including global and country-specific controls, $x_{i,t}$. Only observations for economies adhering to the classical gold standard are used. LP-IV estimates displayed with solid black lines and 90% confidence bands as dashed lines.

These results are consistent with previous research that focused on different time periods and country samples. However, they also highlight that economies are hit by multiple shocks, and that these shocks may interact. For example, an increase in the price of the principal export may either occur at a time where interest rates are increasing or decreasing due to interest movements in the UK. In the next section, we explicitly test for how the effects of export-price shocks are dependent on whether interest rates are countercyclical or procyclical.

5. Estimating the Effects of Export Price shocks under Countercyclical Interest Rates

Because our empirical approach identifies shocks to economies that are uncorrelated with each other and that exhibit substantial cross-sectional and time-series variation, we can analyze how combinations of shocks affect macroeconomics outcomes, particularly combinations which have implications for macroeconomic stabilization policy. We examine how the domestic economy responds when interest rates move countercyclically relative to export price shocks, and compare them to periods when they are procyclical or acyclical.

Economies on the gold standard often adjusted their domestic interest rates in response to interest-rate shocks to maintain their hard pegs. This fact allows us to estimate the effects of countercyclical interest rates. To be clear, we are not claiming that policymakers in the 19th century had a coherent view of how short-run monetary policy affected output and inflation. However, because the currency pegs of the gold standard anchored policy making, these interest- rate movements were less likely to be endogenous. Moreover, policy makers had a singular focus on maintaining their pegs (Capie et al., 1994; Bordo and Rockoff, 1996; Eichengreen, 1998), so our results can be interpreted as causal identification of countercyclical interest-rate shocks for economies with the stated policy objective of nominal anchoring.[17]

To analyze the macroeconomic effects of countercyclical interest rate shocks, we first split the sample between countercyclical interest rates and non-countercyclical interest rates, again focusing on economies that formally adhered to the gold standard. Splitting the sample is consistent with the "commodity" and "interest rate" lotteries described earlier. If both shocks are plausibly exogenous, then their combination is also plausibly exogenous. Using only data for economies adhering to the gold standard ensures that the treatment (countercyclical interest rates) and control groups (non-countercyclical) are under the same institutional framework. Unlike Jordà et al (2020), we exclude economies not on the gold standard, for which the estimated instrument R would be

[17] We stop short of interpreting our results as countercyclical monetary *policy* due to the Lucas critique. Instead, we interpret our results as the effect of countercyclical interest rate shocks, that is, changes in interest rates that are not anticipated by domestic agents.

equal to zero. Although this does not impact our estimates for the causal effects of interest rates provided in section 4, these observations would be erroneously recorded in our dummy variables as "acyclical" interest-rate movements and contaminate the experiments in this section.

To define countercyclical interest rates, we construct a countercyclical dummy variable that takes on the value of one for a particular observation if estimated interest-rate shocks in the UK are negative and export price growth is below the full sample average across all economies. This variable also takes on the value of one if estimated interest-rate shocks in the UK are positive and export price growth for a particular economy is above average. The countercyclical dummy variable takes on the value of zero for non-procyclical interest rates, which occur when interest rate changes are zero (acyclical) or move in the opposite direction relative to export prices (procylical).

The first two columns in table 7 display the results related to countercyclical interest rates. As the estimated coefficients show, following a principal-export price shock, changes in output and prices are dampened when UK interest rates are countercyclical. By contrast, changes in output and prices are large for the procyclical or acyclical cases. These differences are even larger for prices. To illustrate these results, figure 6 plots the responsiveness of output and prices to export price shocks in countercyclical and other periods. The thick dashed red line indicates the path of the outcome variable in countercyclical episodes whereas the solid black line indicates all other cases. The left panel of figure 6 shows that the point estimates of real GDP per capita is much larger when interest rates are procyclical or acyclical, relative to countercyclical rates. The right panel of figure 6 shows that countercyclical policy is successful in keeping domestic prices under control. These effects are statistically significantly different from each other at the 10% level after four years. They are present even after controlling for a global and domestic controls that include country fixed effects, world real GDP per capita growth, the UK inflation rate, and dummy variables for international and domestic financial crises.[18]

[18] The p-values for the Hausman test at horizon zero that the OLS estimates are equal to the IV estimates equals 0.022 for the real GDP regression and 0.04 for the price level regression in the countercyclical sample, and 0.14 and 0.08, respectively, in the procyclical/acyclical sample.

Table 7: Local Projections Instrumental Variables Estimates for the Response of Real GDP per Capita and the Price Level to Export-Price Shocks under Countercyclical or Procyclical/Acyclical Interest Rates

(Domestic rates instrumented by R)

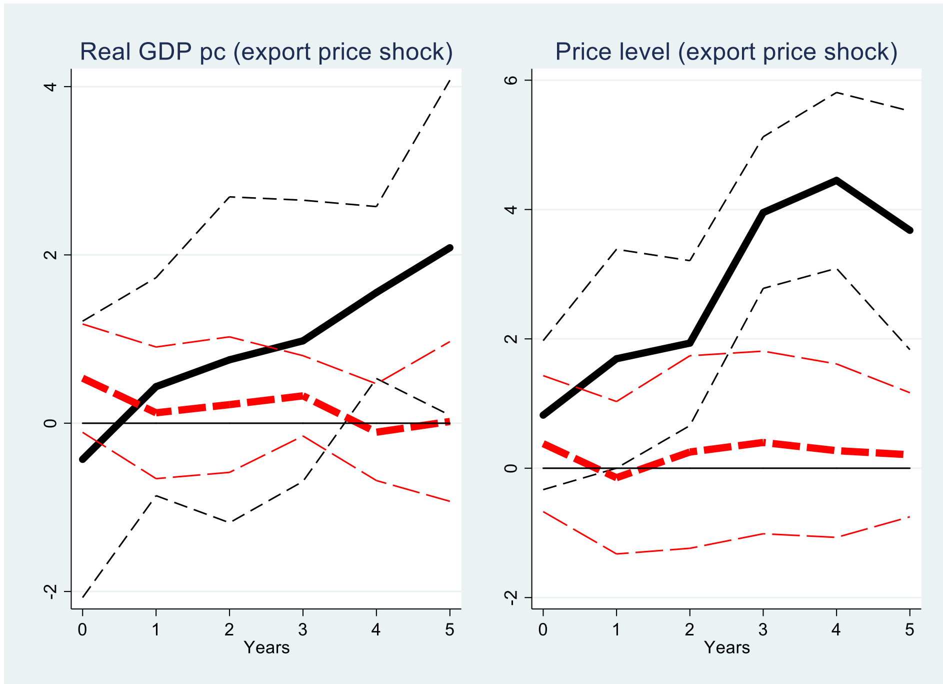
Responses at years 0 to 5 (100 x log change from baseline)

	Log change export-price			
	Countercyclical		Procyclical/Acyclical	
Year after shock	Real GDP	Price Level	Real GDP	Price Level
h=0	0.047	0.033	-0.038	0.072
	(0.034)	(0.056)	(0.087)	(0.061)
h=1	0.011	-0.013	0.037	0.148*
	(0.042)	(0.063)	(0.069)	(0.090)
h=2	0.019	0.022	0.066	0.169**
	(0.042)	(0.079)	(0.102)	(0.068)
h=3	0.028	0.035	0.085	0.345***
	(0.025)	(0.075)	(0.089)	(0.062)
h=4	-0.009	0.024	0.136**	0.388***
	(0.031)	(0.071)	(0.054)	(0.072)
h=5	0.002	0.018	0.182*	0.321***
	(0.050)	(0.051)	(0.106)	(0.098)
Kleibergen-Paap F-stat	14.5	11.7	10.3	9.22
Number of economies	25	26	26	26
Observations at h=0	318	320	262	268

Notes: The dependent variable is defined as either real GDP per capita or the price level (100 x log change from year baseline). The independent variables are 100x the log change of the principal export-price and the change in the domestic interest rate, instrumented by R as defined in equation (1). LP-IV estimates are obtained using equation (6) for the countercyclical and procyclical/acyclical sub-samples, using observations of countries adhering to the gold standard. All regressions include country fixed effects, the world real GDP per capita growth, the UK inflation rate, and dummy variables for international and domestic financial crises, contemporaneously and with one lag, as well as one lag of the dependent and the independent variables. *** p<0.01, ** p<0.05, * p<0.1. Clustered standard errors by country are shown in parentheses.

Figure 6: Local Projections Instrumental Variables Estimates for the Response of Real GDP per Capita and the Price Level to Export-Price Shocks under Countercyclical or Procyclical/Acyclical Interest Rates

(Red, long-dashed, lines correspond to countercyclical sample)



Notes: Real GDP per capita (left panel) and price level (right panel) response to a one-standard-deviation increase in the log change of real principal-export prices. Red, long-dashed, lines correspond to the countercyclical interest rates sample. Black lines capture the procyclical or acyclical interest rates sample. All panels show the baseline model including global and country-specific controls, $x_{i,t}$. Only observations for economies adhering to the classical gold standard are used. LP-IV estimates displayed with solid black lines (procyclical or acyclical interest rates), or red long-dash lines (countercyclical interest rates) and 90% confidence bands as black dashed and red long-dash lines, respectively.

6. Robustness and further results

This section explores the robustness of our findings from section 5 and presents additional results. For economy of exposition, we only display the graphs showing the responsiveness of output and prices.[19]

6.1 Alternative measures for the interest-rate shock

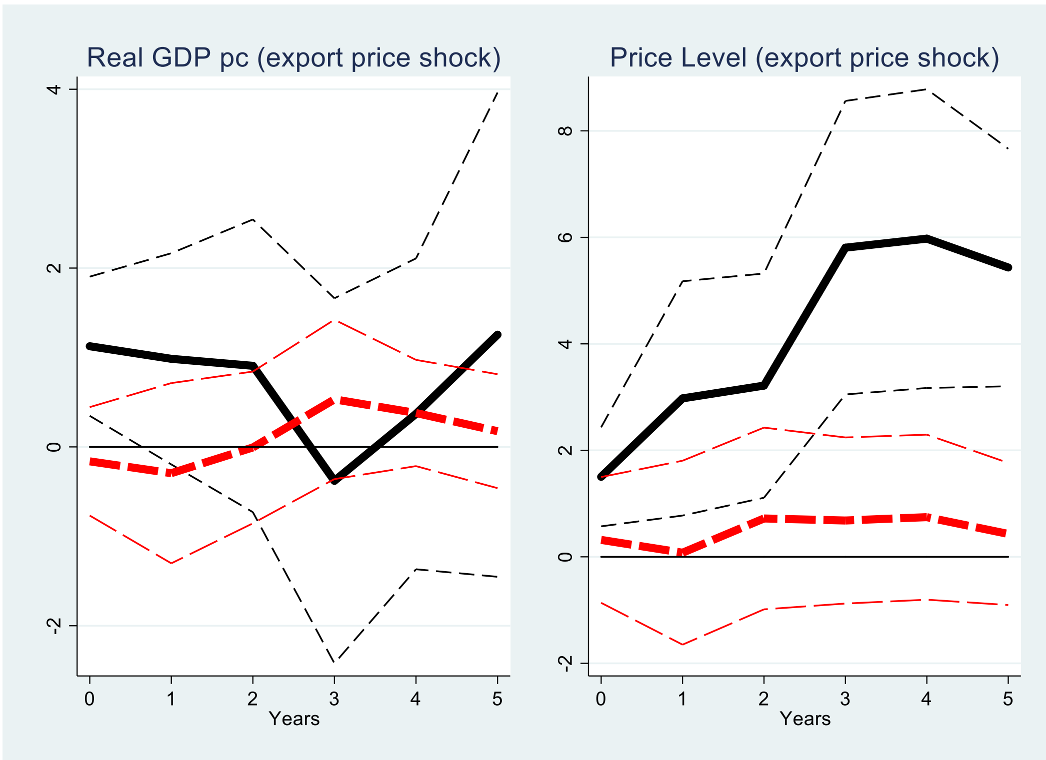
We have defined interest-rate shock as interest-rate movements in the UK that are unexplained by domestic macroeconomic conditions, world trends in export prices, and world growth. Alternatively, we can use the interest-rate shocks computed by Jordà et al. (2020), which are obtained using a smaller set of countries, but a larger set of controls and a larger time-sample, for the estimation of the instrumental variable defined in equation (1).[20] The estimated instrument from Jordà et al. (2020) is very close to the raw UK interest rate changes between 1870 and 1913. The correlation coefficient between the two is equal to 0.92. Using this instrument, we again define countercyclical dummies as explained in section 5 and re-estimate the causal effects of export price shocks for different interest rate movements. The F-statistics of the first stage using these data are 13.8 for the countercyclical sample and 9.7 for the acyclical and procyclical sample, for the real GDP regressions, and 12 and 9.1 for the regressions on the price level, respectively.

Figure 7 shows that when we employ Jordà et al.'s (2020) estimated interest-rate shocks prices and real GDP respond very similarly to those shown in Figure 6, although with some differences in terms of timing. The results for the price level most closely mirror our baseline specification. The effect on real GDP from an export-price shock in the acyclical and procyclical case is now stronger on impact but the estimates are not different from the countercyclical sample after year three.

[19] Tables with the relevant coefficients are available on request.
[20] These data are available on Alan M. Taylor's webpage (https://amtaylor.ucdavis.edu/).

Figure 7: Alternative Local Projections Instrumental Variables Estimates for the Response of Real GDP per Capita and the Price Level to Export-Price Shocks under Countercyclical or Procyclical/Acyclical Interest Rates

(Figures use estimated instrument from Jordà et al. (2020); red, long-dashed, lines correspond to countercyclical sample)



Notes: Real GDP per capita (left panel) and Price Level (right panel) response to a one-standard-deviation increase in the log change of real principal-export prices. Red, long-dashed, lines represent countercyclical interest rates. Black lines capture procyclical or acyclical interest rates. All panels show the baseline model including global and country-specific controls, $x_{i,t}$. Only observations for economies adhering to the classical gold standard are used. LP-IV estimates displayed with solid black lines (procyclical or acyclical interest rates), or long-dash lines (countercyclical interest rates) and 90% confidence bands as black dashed and red long-dash lines, respectively.

6.2 Reduced form

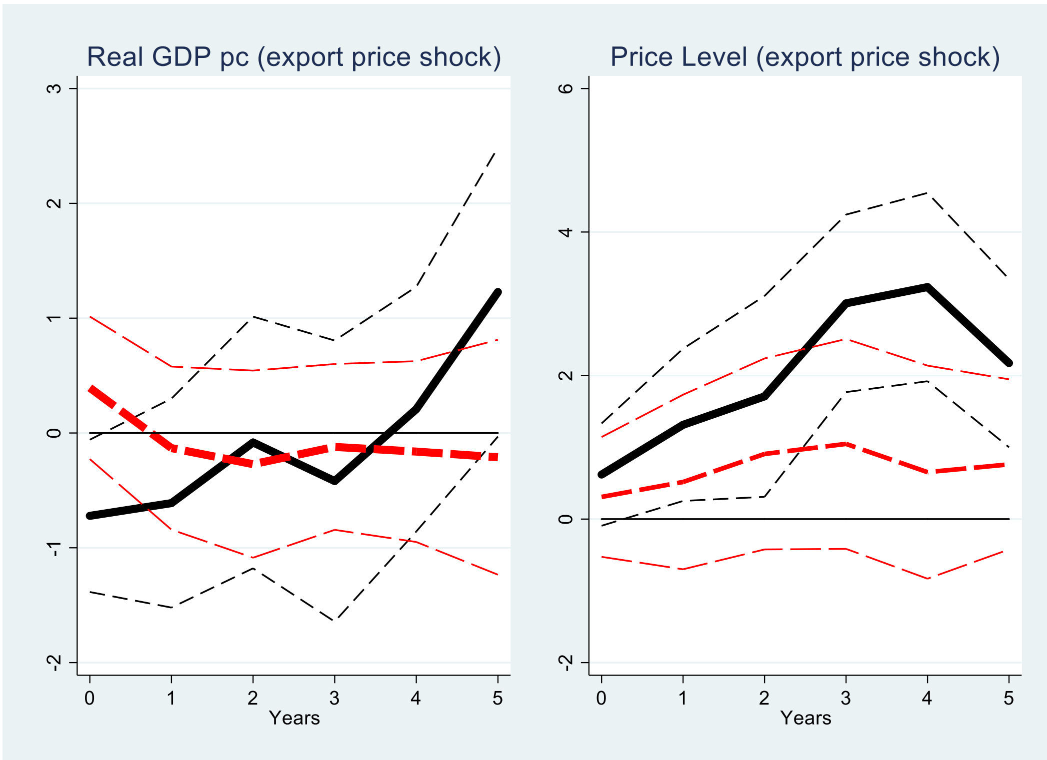
One of the constraints in our analysis is missing historical data on domestic short-interest rates for some economies. In this subsection, we present results from the reduced form regression in the instrumental variable approach. In other words, we directly include the instrument *R* in the regression for economic outcomes. This approach increases the sample of economies for GDP regressions from 26 to 38, and from 26 to 31 for the price level regressions. Figure 8 shows that the results are in line with the findings from the full IV approach estimated earlier: responses of GDP and the price level are more muted under countercyclical interest rates. As an additional comparison, Figure 9 matches the sample with the 26 economies for which we can run the regressions in section 5; the results are quite similar to those shown previously.

6.3 Removing potential monopolists and non-commodity exporters

As an additional check on our findings, we omit economies that could potentially be price-makers in their principal exports, following the approach in Blattman et al. (2007). To be precise, we remove economies that produce more than one-third of the global share of exports in any commodity and/or more than 5% of global exports. These criteria result in dropping Australia, Chile, India, and Russia from our sample. Figure 10 shows that removing monopoly producers of exports yields results consistent with the findings for the full sample. Figure 11 removes Belgium and Netherlands, two economies that are not commodity exporters. The key findings are unchanged when these economies are excluded.

Figure 8: Reduced-Form, Local Projections Instrumental Variables Estimates for the Response of Real GDP per Capita and the Price Level to Export-Price Shocks under Countercyclical or Procyclical/Acyclical Interest Rates

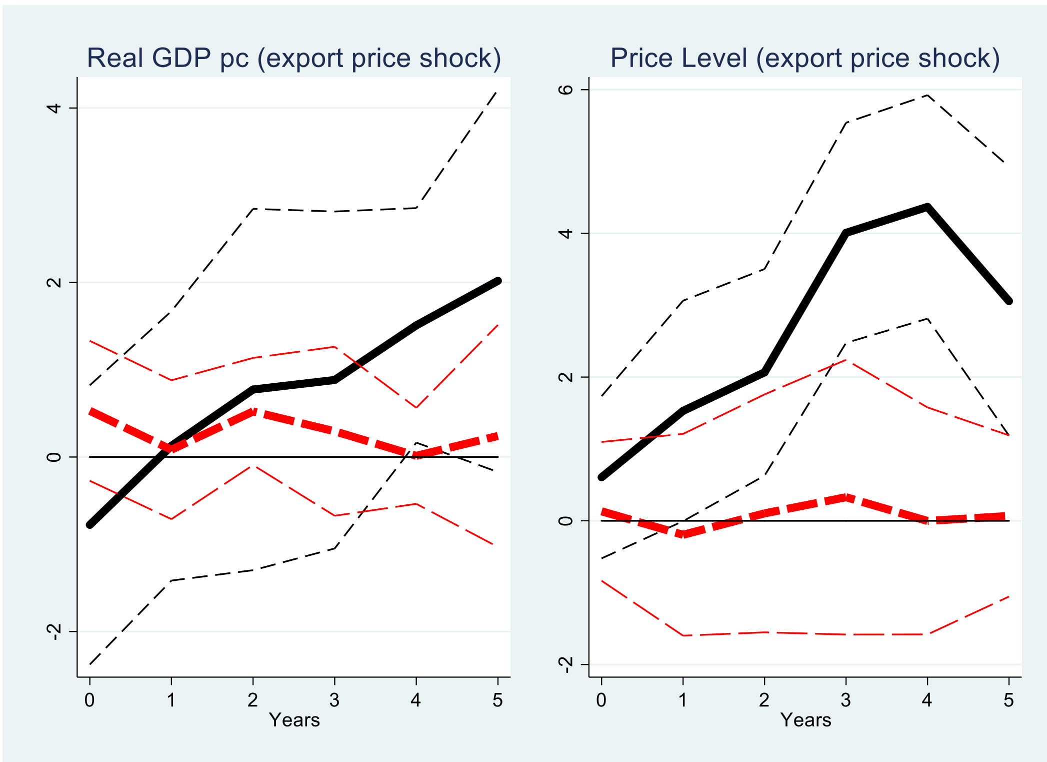
(Red, long-dashed, lines correspond to countercyclical sample)



Notes: Real GDP per capita (left panel) and price level (right panel) response to a one-standard-deviation increase in the log change of real principal-export prices. Red, long-dashed, lines represent countercyclical interest rates. Black lines capture procyclical or acyclical interest rates. All panels show the baseline model including global and country-specific controls, $x_{i,t}$. Only observations for economies adhering to the classical gold standard are used. LP-IV reduced from estimates displayed with solid black lines (procyclical or acyclical interest rates), or long-dash lines (countercyclical interest rates) and 90% confidence bands as black dashed and red long-dash lines, respectively.

Figure 9: Reduced-Form, Local Projections Instrumental Variables Estimates for the Response of Real GDP per Capita and the Price Level to Export-Price Shocks under Countercyclical or Procyclical/Acyclical Interest Rates

(Matching sample of economies to full IV approach, red, long-dashed, lines correspond to countercyclical sample)



Notes: Real GDP per capita (left panel) and price level (right panel) response to a one-standard-deviation increase in the log change of real principal-export prices. Red, long-dashed, lines represent countercyclical interest rates. Black lines capture procyclical or acyclical interest rates. All panels show the baseline model including global and country-specific controls, $x_{i,t}$. Only observations for economies adhering to the classical gold standard are used. LP-IV reduced from estimates displayed with solid black lines (procyclical or acyclical interest rates), or long-dash lines (countercyclical interest rates) and 90% confidence bands as black dashed and red long-dash lines, respectively.

Figure 10: Local Projections Instrumental Variables Estimates for the Response of Real GDP per Capita and the Price Level to Export-Price Shocks under Countercyclical or Procyclical/Acyclical Interest Rates. Sample removes monopolists.

(Red, long-dashed, lines correspond to countercyclical sample)

Notes: Real GDP per capita (left panel) and Price Level (right panel) response to a one-standard-deviation increase in the log change of real principal-export prices. Red, long-dashed, lines represent countercyclical interest rates. Black lines capture procyclical or acyclical interest rates. All panels show the baseline model including global and country-specific controls, $x_{i,t}$. Only observations for economies adhering to the classical gold standard are used. Potential price-makers omitted (see text). LP-IV reduced from estimates displayed with solid black lines (procyclical or acyclical interest rates), or red long-dash lines (countercyclical interest rates) and 90% confidence bands as dashed and long-dash lines, respectively.

Figure 11: Local Projections Instrumental Variables Estimates for the Response of Real GDP per Capita and the Price Level to Export-Price Shocks under Countercyclical or Procyclical/Acyclical Interest Rates. Sample removes non-commodity exporters.

(Red, long-dashed, lines correspond to countercyclical sample)

Notes: Real GDP per capita (left panel) and Price Level (right panel) response to a one-standard-deviation increase in the log change of real principal-export prices. Red, long-dashed, lines represent countercyclical interest rates. Black lines capture procyclical or acyclical interest rates. All panels show the baseline model including global and country-specific controls, $x_{i,t}$. Only observations for economies adhering to the classical gold standard are used. Non-commodity exporters excluded from the sample. LP-IV reduced from estimates displayed with solid black lines (procyclical or acyclical interest rates), or red long-dash lines (countercyclical interest rates) and 90% confidence bands as dashed and long-dash lines, respectively.

7. Conclusion

We use quasi-experimental evidence from the first era of globalization to analyze how interest rates can stabilize an economy following external shocks. Focusing on this earlier historical era allows us to generate causal estimates of the effects of exogenous combinations of export-price and interest-rate shocks for a panel of economies, and to obtain plausible empirical identification of different monetary policy stances by economies adhering to fixed exchange rates. As we emphasize, using this earlier period of history as a laboratory to understand countercyclical interest rates has advantages for producing empirical estimates with a causal interpretation. The subsequent emergence of trade and capital controls, which are not easily measured over time, as well as the broader use of fiscal policy, makes it more challenging to obtain exogenous combinations of real and policy shocks using data from more recent periods.

Our results suggest that countercyclical interest rates can stabilize economies following export-price shocks and thus provide empirical evidence that is grounded on causal identification for the state-dependent effects of monetary shocks. Our findings are particularly relevant for commodity exporters since these economies are more likely to experience substantial economic fluctuations from their tradeable sector and many adopt fixed exchange rates today. That said, we find that countercyclical interest rates are more effective in stabilizing the price level in comparison to GDP. To be sure, our setting is historical, and the economic and policy environments of the classical gold standard era are different from today, so it is worth acknowledging this limitation. However, it is this historical setting, characterized by trade and financial globalization under currency pegs, together with a lack of explicit macroeconomic stabilization policies, which allows us to estimate the causal effects of countercyclical interest rates. A path for future research, then, is to develop methods and data sets that would allow further validation of our findings for other sample periods.

Finally, we stop short from interpreting our results as the effects of monetary policy. Although interest-rate movements, like the ones we analyze in this paper, are one way in which monetary policy is transmitted to the real economy, our empirical strategy only allows us to identify unexpected movements in interest rates, and therefore is only an approximation for the macroeconomic effects of countercyclical policy making. Given the even more globalized economy of today, understanding the effects of policy variables in stabilizing the economy remains an important agenda for research.

References

Alpanda, Sami, Eleonora Granziera, and Sarah Zubairy (2021). "State Dependence of Monetary Policy across Business, Credit and Interest Rate Cycles." *European Economic Review* 140: Article 103936.

Benguria, Felipe, Felipe Saffie, and Sergio Urzúa (2018). "The Transmission of Commodity Price Super-Cycles." NBER Working Paper 24560.

Blattman, Christopher, Jason Hwang, and Jeffrey G Williamson (2007). "Winners and Losers in the Commodity Lottery: The impact of Terms of Trade Growth and Volatility in the Periphery 1870-1939." *Journal of Development Economics* 82(1): 156-179.

Bloomfield, Arthur (1959). *Monetary Policy under the International Gold Standard: 1880–1915*. Federal Reserve Bank of New York, New York.

Bordo, Michael D. (1997) "Globalization in Historical Perspective." International Monetary Fund, *World Economic Outlook*, Annex: 112-116.

Bordo, Michael D., and Finn E. Kydland (1995). "The Gold Standard as a Rule: An Essay in Exploration." *Explorations in Economic History* 32(4): 423-464.

Bordo, Michael D., and Hugh Rockoff (1996). "The Gold Standard as a "Good Housekeeping Seal of Approval"." *The Journal of Economic History* 56(2): 389-428.

Broda, Christian (2004). "Terms of Trade and Exchange Rate Regimes in Developing Countries." *Journal of International Economics* 63: 31–58.

British Board of Trade. Various years. *Statistical Abstract for the Principal and Other Foreign Countries*. London: Board of Trade.

Caselli, Francesco, and Andrea Tesei (2016). "Resource Windfalls, Political Regimes, and Political Stability." Review of Economics and Statistics 98, no. 3: 573-590.

Catão, Luis, and Roberto Chang (2015). “World Food Prices and Monetary policy.” *Journal of Monetary Economics* 75: 69-8.

Catão, Luis, and Roberto Chang (2013). “Monetary Rules for Commodity Traders.” *IMF Economic Review* 61(1): 52-91.

Corsetti, Giancarlo, Luca Dedola, and Sylvain Leduc (2010). “Optimal Monetary Policy in Open Economies.” *Handbook of Monetary Economics*. Vol. 3. Elsevier: 861-933.

Drechsel, Thomas, and Silvana Tenreyro (2018). “Commodity Booms and Busts in Emerging Economies.” *Journal of International Economics*, 112: 200-218.

Gali, Jordi, and Tommaso Monacelli (2005). “Monetary Policy and Exchange Rate Volatility in a Small Open Economy.” *The Review of Economic Studies* 72(3): 707-734.

di Giovanni, Julian, and Jay C. Shambaugh (2008). “The Impact of Foreign Interest Rates on the Economy: The Role of the Exchange Rate Regime.” *Journal of International Economics* 74(2): 341–361

di Giovanni, Julian, Justin McCrary, and Till Von Wachter (2009). “Following Germany's lead: Using International Monetary Linkages to estimate the effect of Monetary Policy on the economy.” *The Review of Economics and Statistics* 91(2): 315-331.

Eichengreen, Barry. (1998). *Globalizing capital: A History of the International Monetary System*, Princeton University Press.

Fernández, Andrés, Stephanie Schmitt-Grohé, and Martín Uribe (2017). “World Shocks, World Prices, and Business Cycles: An Empirical Investigation.” *Journal of International Economics* 108: S2-S14.

Findlay, Ronald, and Kevin H. O'Rourke (2003) "Commodity Market Integration, 1500-2000." *Globalization in Historical Perspective*. University of Chicago Press: 13-64.

Frankel, Jeffrey. (2017) *How to Cope with Volatile Commodity Export Prices: Four Proposals*. No. 335. Center for International Development at Harvard University.

Frankel, Jeffrey. (2010) “Monetary Policy in Emerging Markets.” *Handbook of Monetary Economics*. Vol. 3. Elsevier: 1439-1520.

Gelos, Gaston, and Yulia Ustyugova (2017). "Inflation Responses to Commodity Price Shocks – How and Why do Economies Differ?" *Journal of International Money and Finance* 72: 28-47.

Hallwood, C. Paul, Ronald MacDonald, and Ian W. Marsh (1996). "Credibility and Fundamentals: were the Classical and Interwar Gold Standards Well-behaved Target Zones?" *Modern perspectives on the gold standard*. Cambridge: Cambridge University Press: 129-61.

Harvey, David I., Neil M. Kellard, Jakob B. Madsen, and Mark E. Wohar (2010). "The Prebisch-Singer Hypothesis: Four Centuries of Evidence." *The Review of Economics and Statistics*, 92(2): 367-377.

Jacobson, Morris Lazarev (1909). *Statistical Abstract of Foreign Economies: Part I-III. Statistics of Foreign Commerce.* US Government Printing Office.

Jordà, Òscar. (2005) "Estimation and Inference of Impulse Responses by Local Projections." *American Economic Review* 95(1): 161-182.

Jordà, Òscar, Moritz Schularick, and Alan M. Taylor (2015). "Betting the House." *Journal of International Economics* 96: S2-S18.

Jordà, Òscar, Moritz Schularick, and Alan M. Taylor (2020). "The Effects of Quasi-random Monetary Experiments." *Journal of Monetary Economics* 112: 22-40.

Keynes, John M. (1930). *The Applied Theory of Money*. Reprinted: Macmillan, 1971.

Klein, Michael W. and Jay C. Shambaugh (2015). "Sources of Monetary Policy Autonomy." *American Economic Journal: Macroeconomics* 7(4): 33-66.

Kose, M. Ayhan (2002). "Explaining Business Cycles in Small Open Economies: How much do World Prices matter?" *Journal of International Economics* 56(2): 299-327.

Krugman, Paul R (1991). "Target Zones and Exchange Rate Dynamics." *The Quarterly Journal of Economics* 106(3): 669-682.

Levy-Yeyati, Eduardo, and Federico Sturzenegger (2003) "To Float or to Fix: Evidence on the Impact of Exchange Rate Regimes on Growth." *The American Economic Review* 93: 1173–93.

Levy-Yeyati, Eduardo and Federico Sturzenegger (2010). "Monetary and Exchange Rate Policies." In Dani Rodrik and Mark Rosenzweig (eds.) *Handbook of Development Economics*. Vol. 5. Elsevier: Amsterdam: 4215-4281.

Mendoza, Enrique G. (1995). "The Terms of Trade, the Real Exchange Rate, and Economic Fluctuations." *International Economic Review*: 101-137.

Mendoza, Enrique G. (1997). "Terms-of-trade Uncertainty and Economic Growth." *Journal of Development Economics* 54(2): 323-356.

Mitchell, Brian R. (1982). *International Historical Statistics: Africa and Asia*. London (United Kingdom) Macmillan Press.

Mitchell, Brian R. (2007a). *European Historical Statistics, 1750-2005.* London (United Kingdom) Macmillan Press.

Mitchell, Brian R. (2007b). *International Historical Statistics 1750-2005*. London (United Kingdom) Macmillan Press.

Mitchener, Kris James, and Marc D. Weidenmier (2015). "Was the Classical Gold Standard Credible on the Periphery? Evidence from Currency Risk." *The Journal of Economic History* 75(2): 479-511.

Mitchener, Kris James, and Gonçalo Pina (2020). "Pegxit Pressure." *Journal of International Money and Finance* 107: Article 102191.

Neal, Larry D., and Marc D. Weidenmier (2003) "Crises in the Global Economy from Tulips to Today." *Globalization in historical perspective*. University of Chicago Press: 473-514.

Obstfeld, Maurice, Jay C. Shambaugh, and Alan M. Taylor (2005). "The Trilemma in History: Tradeoffs among Exchange Rates, Monetary Policies, and Capital Mobility." *Review of Economics and Statistics* 87 (3): 423-438.

Obstfeld, Maurice and Alan M. Taylor (2001). "Globalization and Capital Markets." In Michael D. Bordo, Alan M. Taylor and Jeffrey G. Williamson (eds.) *Globalization in Historical Perspective*. Chicago: University of Chicago Press, pp.121-87.

O'Rourke, Kevin, and Jeffrey G. Williamson (1994). “Late Nineteenth-century Anglo-American Factor-price Convergence: Were Heckscher and Ohlin right?” *The Journal of Economic History* 54(4): 892-916.

O’Rourke, K.H. and J.G. Williamson (1999). *Globalization and History: The Evolution of a Nineteenth Century Atlantic Economy*. Cambridge MA: MIT Press.

Plagborg-Møller, Mikkel, and Christian K. Wolf (2021). "Local Projections and VARs estimate the Same Impulse Responses." *Econometrica* 89(2): 955-980.

Pisha, Arta, Besa Vorpsi, Neraida Hoxhaj, Clemens Jobst, Thomas Scheiber, Kalina Dimitrova, Martin Ivanov et al. (2016). “South-Eastern European Monetary and Economic Statistics from the Nineteenth Century to World War II.” Bank of Greece.

Reinhart, Carmen M., and Kenneth S. Rogoff (2011). “From Financial Crash to Debt Crisis.” *The American Economic Review* 101(5): 1676-1706.

Schmitt‐Grohé, Stephanie, and Martín Uribe (2018). “How Important are Terms-of-Trade Shocks?” *International Economic Review* 59(1): 85-111.

Tenreyro, Silvana, and Gregory Thwaites (2016). "Pushing on a String: US Monetary Policy is Less Powerful in Recessions." *American Economic Journal: Macroeconomics* 8 (4): 43-74.

Vogel, Lukas, Stefan Hohberger, and Bernhard Herz (2015). “Should Commodity Exporters Peg to the Export Price?” *Review of Development Economics* 19(3): 486-501.

Weise, Charles L. (1999). “The Asymmetric Effects of Monetary Policy: A Nonlinear Vector Autoregression Approach.” *Journal of Money, Credit and Banking*: 85-108.

Williamson, Jeffrey G. (2013). *Trade and Poverty: When the Third World Fell Behind*. MIT Press Books.

Data Appendix

Appendix A: Principal exports – sources

For most economies in our sample, we rely on detailed trade data published in the British Board of Trade's *Statistical Abstract*, henceforth SA, to identify principal exports. We supplement and cross-check our estimates with information found in Jacobson (1909), Mitchell (2007a), Mitchell (2007b), Mitchell (1982), Hanson (1980), Blattman et al. (2007), as well as country-specific sources which are referenced in this data appendix. Our goal is to identify the largest export in terms of value between 1870 and 1913, not to construct the full portfolio of exports. We compute export weights for different products in each year and select the product with the largest average weight over the sample period. The list below summarizes our findings, which extends previous data collection in Mitchener and Pina (2020):

Argentina: Wool. Using data from SA, we calculate that on average wool accounted for 32% of exports between 1879-1912, wheat for 17%, hides and skins for 16%, corn for 8% and beef for 6%. This is confirmed by Mitchell (2007b) reports that the average value of wool exports between 1870 and 1914 was 40.2 million gold pesos, compared to 35.7 million gold pesos for wheat and 22.4 million gold pesos for hides and skins.

Australia: Wool. Using data from SA, we calculate that on average wool accounted for 45% of exports between 1900-1906. Blattman et al. (2007) calculate this weight to be 89.3% between 1878 and 1882, and 72.7% between 1898 and 1902.

Austria-Hungary: Wood. Using data from SA, we calculate that on average wood accounted for 11% of exports between 1871-1912, sugar for 8%, wheat and flour for 6% and wool for 6%.

Belgium: Textile manufactures. Using data from SA, we calculate that, on average, textile manufactures accounted for 8% of exports between 1871-1912, coal for 6%, iron for 6%, wheat and flour for 6%.

Brazil: Coffee. Mitchell (2007b) reports that the average value of coffee exports between 1870 and 1904 were 257 million paper milreis. This is larger than average sugar exports (63 million), cotton (16 million) and cocoa (7 million). Blattman et al. (2007) calculate that the weight of coffee in total exports is 70.2% between 1878 and 1882, and 65.4% between 1898 and 1902.

Bulgaria: Wheat. Using data from SA, we calculate that on average wheat accounted for 47% of exports between 1888-1911, corn for 12% and animals for 4%. Chirot (1991) reports that wheat sales represented 70% of Bulgaria’s export totals around 1900.

Canada: Wood. Mitchell (2007b) reports that average value of lumber exports between 1870 and 1913 was 25.6 million Canadian dollars with an additional 2.4 million wood pulp. The second largest was wheat, with 22 million. Blattman et al. (2007) calculate that the weight of lumber in total exports between 1878 and 1882 ia 54.0% and 36.4% between 1898 and 1902.

Chile: Nitrate. Mitchell (2007b) reports that the average value of copper exports between 1870 and 1914 was 29.6 million gold pesos of 18 pence, which is smaller than the value of nitrate exports for the same period (125.4 million gold pesos of 18 pence). Using data from SA, we calculate that on average nitrate accounted for 69% of exports between 1896-1912, copper for 9% and coal for 3%.

China: Silk. Using data from SA, we calculate that on average silk accounted for 33% of exports between 1872-1907. Hanson (1980) documents that silk exports were on average 36.3 million U.S. dollars, followed by tea, valued at 34.4 million dollars.

Denmark: Butter. Using data from SA, we calculate that, on average, butter accounted for 33% of exports between 1879-1912, meat 16%, and cattle for 8%.

Egypt: Cotton. Using data from SA, we calculate that, on average, cotton, including both raw and seeds, accounted for 70% of exports between 1878-1905.

Finland: Wood. According to Vattula (1983), on average timber and wood products accounted for 47% of exports between 1870-1913, butter for 15%, paper for 11% and textiles for 7%. Hjerppe (1989) report that timber and wood products accounted for 46% of Finnish exports between 1869-1913.

France: Wool manufactures. Using data from SA, we calculate that on average wool and wool manufactures accounted for 13% of exports between 1871-1912, silk and silk manufactures for 11%, cotton manufactures for 7%, wine for 8% and hides for 6%. Hanson (1980) reports that for 1900 the largest export for France are silk manufactures (61.5 million U.S. dollars), followed by cotton manufactures (34.9 million U.S. dollars).

Germany: Cotton manufactures. Using data from SA, we calculate that on average cotton textiles accounted for 9% of exports between 1872-1912, iron products for 7%, wool textiles for 6%, wheat and flour for 4%. Hanson (1980) reports that for 1900 the largest exports for Germany are cotton manufactures (67.1 million U.S. dollars), followed by raw sugar (51.5 million U.S. dollars).

Greece: Dried fruits. Using data from SA, we calculate that on average dried fruits accounted for 41% of exports between 1870-1911, lead for 10%, wine for 8% and olive oil for 7%. Blattman et al. (2007) reports that fruits & nuts account for 59% of Greece's exports between 1898 and 1902. The second largest export is lead, accounting for 14.1%.

Iceland: Fish. Bjarnason (2001) shows that fish products accounted for 66.5% of exports between 1870-1913.

India: Cotton. Using data from SA, we calculate that on average cotton ac- counted for 22% of exports between 1873-1913, jute for 12%, rice for 12%, opium for 11% and tea for 6%. Mitchell (1982) reports that the average value of cotton exports between 1870 and 1913 was 167.3 million rupees. Rice accounts for the second largest export, averaging 128.2 million rupees, followed by opium, jute, cotton manufactures, tea and jute manufactures. Blattman et al. (2007) reports that rice accounts for 21.1% of Indias's exports between 1898 and 1902. Other important exports include cotton (16.9%), cotton manufactures (13.8%), jute (13.7%), tea (12.2%), opium (11.7%) and jute manufactures (10.6%).

Italy: Silk. Using data from SA, we calculate that on average silk accounted for 31% of exports between 1871-1912, olive oil for 6%, dried fruits for 4%, wine for 4% and cotton manufactures for 3%. Hanson (1980) reports that for 1900 the largest export for Italy are silk manufactures (86.6 million U.S. dollars), followed by cotton manufactures (11.8 million U.S. dollars).

Japan: Silk. Using data from SA, we calculate that on average silk accounted for 40% of exports between 1881 and 1912, tea for 9%, cotton manufactures for 7%, coal for 5%, copper for 5% and rice for 4%. Mitchell (1982) reports that the average value of raw silk exports between 1870 and 1913 was 46.15 million yen, followed by cotton yarn and fabrics (25.9 million yen) and silk fabrics (19 million yen).

Malaysia: Tin. Mitchell (1982) reports that the average value of tin exports between 1870 and 1913 was 38 million straits dollars, which is larger than the second largest export, rubber, accounting for 7 million straits dollars.

Mexico: Silver. Using data from SA, we calculate that, on average, silver accounted for 55% of exports between 1879 and 1912, coffee for 7%, copper for 5% and gold for 4%. Mitchell (2007b) reports that the average value of silver exports between 1870 and 1913 was 52.5 million pesos, much larger than the second largest export, coffee (6.7 million pesos).

Netherlands: Iron products. Using data from SA, we calculate that, on average, iron products accounted for 8% of exports between 1871 and 1912, drugs (Peruvian bark) for 6%, flour for 6% and cotton manufactures for 5%. Hanson (1980) reports that for 1900 the largest export for Netherlands are cotton manufactures (16.2 million U.S. dollars), followed by dyes and dyestuffs (9.1 million dollars).

Norway: Wood. Using data from SA, we calculate that, on average, wood accounted for 33% of exports between 1871 and 1912, fish for 30% and paper for 5%. Blattman et al. (2007) reports that wood and products accounted for 44% of Norway's exports between 1898 and 1902, while fish accounted for 50%.

Peru: Sugar. Using data from SA, we calculate that on average sugar accounted for 28% of exports between 1902 and 1906, the largest for available data. Blattman et al. (2007) calculate this weight to be 47.9% between 1878 and 1882, and 31.9% between 1898 and 1902. Silver is the second most export product from Peru, 26.4% and 22.9% in Blattman et al. (2007), respectively.

Philippines: Hemp. Using data from SA, we calculate that on average hemp accounted for 65% of exports between 1900 and 1907, the largest for available data there. Blattman et al. (2007) calculate this weight to be 73.5% between 1898 and 1902.

Portugal: Wine. Using data from SA, we calculate that on average wine products accounted for 42% of exports between 1871 and 1906.

Romania: Wheat. Using data from SA, we calculate that on average wheat accounted for 39% of exports between 1882 and 1911, maize for 22%, barley for 8%, rye for 4% and flax for 4%. Chirot (1991) reports that wheat sales represented 80% of Romania's export totals circa 1900.

Russia: Wheat. Using data from SA, we calculate that on average wheat accounted for 25% of exports between 1871 and 1912, flax 9%, rye and ryemeal 9%, barley 6% and oats 6%. Blattman et al. (2007) reports that grain accounted for 63% of Russia's exports between 1898 and 1902, 65% between 1878 and 1882.

Sweden: Wood. Using data from SA, we calculate that on average wood accounted for 40% of exports between 1871 and 1912, iron for 16%, butter for 8%, and paper for 7%. Johansson (1967) reports that, between 1891 and 1895, wood products accounted for 28% of Sweden's exports.

Spain: Wine. Using data from SA, we calculate that, on average, wine accounted for 25% of exports between 1879 and 1906, the largest for available data. This is followed by iron, which accounts for 9%.

Sri Lanka: Tea. Mitchell (1982) reports that the average value of tea exports between 1873 and 1913 was 41 million rupees, which is larger than coffee exports, which are equal to 17 million.

Switzerland: Textile manufactures. Using data from SA, we calculate that on average silk and silk manufactures accounted for 26% of exports between 1885 and 1912, cotton manufactures for 20%, butter and cheese for 8%. Hanson (1980) reports that in 1900 the largest export for Switzerland are silk manufactures (40.7 million U.S. dollars), closely followed by cotton manufactures (32.9 million U.S. dollars).

Taiwan: Sugar. Given that data for macroeconomic outcomes are only available from 1898 onwards, we record sugar as the principal export. Ho (1975) documents that sugar represented

27.8% of exports between 1900-1909, followed by rice with 23.2%.

Turkey: Fruit and nuts. According to Mitchell (1982), on average, the largest export was fruits and nuts (2372 thousand Turkish lira between 1878 and 1913), followed by silk (1160 thousand Turkish lira), and wool & mohair (1074 thousand Turkish lira). Blattman et al. (2007) reports that fruits and nuts accounted for 32.6% exports between 1898 and 1902 and 35.7% between 1878 and 1882.

United States of America: Cotton. Using data from SA, we calculate that on average cotton accounted for 29% of exports between 1871 and 1912, wheat for 14%, meats for 13%, and petrol for 5%. Mitchell (2007b) reports that the average value of cotton exports between 1870 and 1913 was 250 million U.S. dollars, larger than the second largest export, wheat (averaging 108 million U.S. dollars).

Uruguay: Wool. Using data from SA, we calculate that on average wool accounted for 32% of exports between 1888 and 1906.

Venezuela: Coffee. Mitchell (2007b) reports that the average value of coffee exports between 1870 and 1913 was 50 million bolivars, much larger than the second largest export, petroleum (1.2 million bolivars).

Additional References used in Collecting Principal Exports and cited only in the Data Appendix

Bjarnason, Halldor (2001). *The Foreign Trade of Iceland, 1870-1914: An Analysis of Trade Statistics and a Survey of Its Implications for the Icelandic Economy*. University of Glasgow (United Kingdom).

Chirot, Daniel, ed. (1991). *The Origins of Backwardness in Eastern Europe: Economics and Politics from the Middle Ages until the Early Twentieth Century*. University of California Press.

Hjerppe, Riitta (1989). *The Finnish Economy 1860-1985: Growth and Structural Change*.

Johansson, Ö., (1967). *The Gross Domestic Product of Sweden and its Composition 1861–1955*. Stockholm Economic Studies Uppsala.

Ho, Samuel PS (1975). “The Economic Development of Colonial Taiwan: Evidence and Interpretation.” *Journal of Asian Studies* 34, no. 2: 417-439.

Vattula, Kaarina (1983). *The Economic History of Finland: Historical Statistics*. Helsinki: Kustannusosakeyhtiö Tammi.

Appendix B: Data availability and sources for Macroeconomic Data

Appendix Table 1 summarizes available data by country. Most of the GDP data is from Barro and Ursúa (2010), while inflation rates are from Reinhart and Rogoff (2011). Sources as reported in these two references. Additional data comes from Maddison (2013) and Pisha et al. (2015) as explained in the text.

Sources for interest rates otherwise not available in Weidenmier and Neal (2003), Mitchener and Weidenmier (2015) or Jordà et al. (2015):

- Canada: Montreal call rates. Furlong, Kieran. (1999). "Economic fluctuations in Canada, 1867-1897." PhD diss., National Library of Canada [Bibliothèque nationale du Canada].
- Egypt: Hansen, Bent. (1983): "Interest rates and foreign capital in Egypt under British occupation." *The Journal of Economic History* 43(4) 867-884.
- Iceland: GFD database. Iceland 3-month REIBOR (Reykjavik Interbank Offer Rate): Central Bank of Iceland, Quarterly Bulletin and web site. For more information on the REIBOR/REIBID market, see www.sedlabanki.is/uploads/files/MB023%204.pdf
- Peru: Average discount rates on bills of exchange from banks (%). Quiroz, Alfonso. (1986). "Financial Institutions in Peruvian Export Economy and Society, 1884-1930." PhD Thesis in History, Columbia University, p. 430-31. Quiroz obtained the data from contemporary newspapers and magazines including *El Comercio, El Financista, El Economista, Economista Peruano, La Gaceta Comercial, Revista de Cambios y Valores.*

Appendix Table 1: Data Summary by Country

Economy	Real GDP	Price level	Principal Export	Short-term Domestic Interest Rate	Gold Standard dates between 1870 - 1913	Correlation between Instrument and export-shock conditional on Gold Standard Adherence
Argentina	1875-1913	1870-1913	Wool	1880-1913	1870-1876, 1883-1884, 1900-1913	0.31
Australia	1870-1913	1870-1913	Wool	1870-1913	1870-1913	0.15
Austria-Hungary	1870-1913	1870-1913	Timber	1870-1913	1892-1913	0.40*
Belgium	1870-1913	1870-1913	Textile Products	1870-1913	1879-1913	0.20
Bolivia	1890-1913		Tin		1908-1913	0.02
Brazil	1870-1913	1870-1913	Coffee		1888-89, 1906-1913	0.0
Bulgaria	1887-1913	1888-1913	Wheat	1888-1913	1903-1913	-0.47
Canada	1870-1913	1870-1913	Timber	1871-1897 (Call rates) and 1902-1913	1870-1913	0.09
Chile	1870-1913	1870-1913	Nitrate	1870-1913	1895-1898	0.71
China	1890-1913	1870-1913	Silk	-	-	
Colombia	1905-1913	1870-1913	Coffee	-	-	
Denmark	1870-1913	1870-1913	Butter	1870-1913	1874-1913	0.04
Egypt	1894-1913	1870-1913	Cotton	1883-1913	1885-1913	0.29
Finland	1870-1913	1870-1913	Timber	1870-1913	1878-1913	0.01
Greece	1870-1913	1870-1913	Fruits and nuts	1870-1913	1885, 1910-1913	-0.61
Iceland	1870-1913	1875-1913	Fish	1903-1913 (Interbank rates)	1873-1913	-0.30*
India	1872-1913	1870-1913	Cotton	1879-1913	1898-1913	0.41
Indonesia	1880-1913	1870-1913	Sugar	-	1875-1913	-0.16
Italy	1870-1913	1870-1913	Silk	1870-1913	1884-1894	0.41
Japan	1870-1913	1870-1913	Silk	1879-1913	1897-1917	0.37

Economy	Real GDP	Price level	Principal Export	Short-term Domestic Interest Rate	Gold Standard dates between 1870 - 1913	Correlation between Instrument and export-shock conditional on Gold Standard Adherence
Malaysia	1900-1913	-	Tin	-	1903-1913	0.31
Mexico	1895-1913	1877-1913	Silver	1900-1913	1905-1913	0.40
Netherlands	1870-1913	1870-1913	Iron prod.	1870-1913	1875-1913	0.12
New Zealand	1870-1913	1870-1913	Wool	-	1870-1913	0.15
Norway	1870-1913	1870-1913	Timber	1870-1913	1873-1913	0.04
Peru	1870-1913	1900-1913	Sugar	18973-1913	1901-1913	-0.30
Philippines	1902-1913	-	Hemp	-	1903-1913	0.40
Portugal	1870-1913	1870-1913	Wine	1880-1913	1870-1891	-0.17
Romania	1870-1913	1880-1913	Wheat	1881-1913	1890-1913	-0.11
Russia	1870-1913	1870-1913	Wheat	1870-1913	1897-1913	-0.40
Spain	1870-1913	1870-1913	Wine	1874-1913		
Sri Lanka	1870-1913	-	Tea	-	1870-1913	0.09
Sweden	1870-1913	1870-1913	Timber	1870-1913	1874-1913	0.03
Switzerland	1870-1913	1870-1913	Silk mf.	1870-1913	1878-1913	0.10
Taiwan	1901-1913	1897-1913	Sugar	-	1898-1913	-0.34
Turkey	1875-1913	1870-1913	Fruits and nuts		1880-1913	0.13
UK	1870-1913	1870-1913	-	1870-1913	1870-1913	
USA	1870-1913	1870-1913	Cotton	1870-1913	1878-1913	0.18
Uruguay	1870-1913	1879-1913	Wool	-	1877-1913	0.16
Venezuela	1870-1913	1870-1913	Coffee	-	-	

Notes: the correlation between instrument and export-shock column shows within country correlation for the value of the instrument $R_{i,t}$, defined as changes in the UK interest rate after removing domestic and global factors and the percentage change of real-principal export price (see text for further details on the measurement of these two variables), for economies formally adhering to the gold standard.